DOCUMENTS OF THE FISHERY RESOURCES AND EXPLOITATION DIVISION OF FAO DEPARTMENT OF FISHERIES

DOCUMENTS DE LA DIVISION DES RESSOURCES ET DE L'EXPLOITATION DES PECHES DU DÉPARTEMENT DES PECHES DE LA FAO

DOCUMENTOS DE LA DIRECCION DE RECURSOS PESQUEROS Y EXPLOTACION DEL DEPARTAMENTO DE PESCA DE LA FAO

Documents which are not official FAO publications are issued in several series They are given a restricted distribution and this fact should be indicated if they are cited. Most of them are prepared as working papers for meetings, or are summaries of information for use of member governments, organizations, and specialists concerned

Des documents qui ne figurent pas parmi les publications officielles de la FAO sont publiés dans diverses séries. Ils font seulement l'objet d'une distribution restreinte, aussi convient-il de le préciser lorsque ces documents sont cités. Il s'agit le plus souvent de documents de travail préparés pour des réunions, ou de résumés d'information à l'intention des gouvernements des pays membres, ainsi que des organisations et spécialistes intéressés. Ces séries sont les suivantes:

Esta Subdirección publica varias series de documentos que no pueden considerarse como publicaciones oficiales de la FAO. Todos ellos tienen distribución limitada, circunstancia que debe indicarse en el caso de ser citados. La mayoría de los títulos que figuran en dichas series son documentos de trabajo preparados para reuniones o resúmenes de información destinados a los estados miembros, organizaciones y especialistas interesados.

FAO Fisheries Report	**FR /R (No.)**
FAO Fisheries Circular	**FR /C (No.)**
FAO Fisheries Synopsis	**FR /S (No.)**

Special groups of synopses are identified by symbols followed by classification numbers based on indexed code of "Current Bibliography":

SAST	Data concerning certain species and fish stocks
MAST	Information on methods and subjects
OT	Oceanographic data
IT	Limnological data.
	and
CART	Information concerning fisheries and resources of certain countries and regions (FID/S).

Des catégories spéciales de synopses sont identifiées à l'aide de symboles suivis des chiffres de classification basés sur le code d'indexation de la « Current Bibliography »:

SAST	Données sur certaines espèces et populations de poissons.
MAST	Renseignements sur des méthodes et des sujets.
OT	Données océanographiques.
IT	Données limnologiques.
	et
CART	Renseignements sur les pêcheries et les ressources de certains pays et régions (FD/S).

Grupos especiales de sinopsis se distinguen con las siglas siguientes, seguidas por números de clasificación que se basan en las claves de los índices de la « Current Bibliography »

SAST	Datos relativos a ciertas especies y poblaciones
MAST	Sinopsis sobre métodos y materias.
OT	Sinopsis sobre oceanografía.
IT	Sinopsis sobre limnología.
	y
CART	Información sobre los recursos acuáticos vivos de algunos países y regiones (FID/S).

FAO Fisheries Technical Paper **FR /T (No.)**

Special groups of Technical Papers are identified by:

RE	Indexed lists of experts and institutions drawn from Registers maintained by the Fishery Resources and Exploitation Division.
CB	Lists of periodicals, special sections of "Current Bibliography for Aquatic Sciences and Fisheries", special bibliographies and papers concerning documentation problems.
MFS	Provisional editions of "FAO Manuals in Fisheries Science".

Some documents also have another identification, if, for example, they have been contributed to a meeting for which papers have been numbered according to another system.

Des catégories spéciales de documents techniques sont identifiées à l'aide des symboles suivants:

RE	Listes indexées d'experts et institutions tirées des registres tenus à jour par la Division des ressources et de l'exploitation des pêches.
CB	Listes de périodiques, des sections spéciales de la « Current Bibliography for Aquatic Sciences and Fisheries », des bibliographies particulières et des articles sur les problèmes de documentation.
MFS	Editions provisoires des « Manuels FAO de science halieutique ».

Parfois certains documents portent d'autres numéros d'identification, par exemple, s'ils ont été préparés pour une réunion dont les documents ont été marqués à l'aide d'un autre système.

Grupos especiales de documentos técnicos se identifican por las siglas siguientes:

RE	Listas índices de expertos y de instituciones tomadas de los registros que se llevan en la Dirección de Recursos Pesqueros y Explotación.
CB	Listas de periódicos, secciones especiales de la « Current Bibliography for Aquatic Sciences and Fisheries », bibliografías especiales y trabajos relativos a los problemas de documentación.
MFS	Ediciones provisionales de los « Manuales de la FAO de Ciencias Pesqueras ».

Algunos documentos tienen también otra identificación si, por ejemplo, son contribuciones a una reunión cuyos documentos han sido marcados con arreglo a otros sistemas.

FAO Fisheries Technical Paper No. 71
(Distribution restricted)

FRm/T71(En)
Meteorology

FISHERMEN AND THE WEATHER

by

K. Terada

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, February 1968

PREPARATION OF THIS PAPER

This paper was prepared as a model, with a view to assisting member nations to draft their own booklets to help fishermen understand better and apply practical meteorology in their profession, and to encourage their cooperation in providing meteorological information from ocean areas where fishing fleets operate.

Distribution:

FAO Department of Fisheries
FAO Member Countries
FAO Regional Fisheries Officers
WMO
IOC
ACMRR
SCOR

"Current Bibliography" entry:

Terada, K. (1968) 13-1M038
FAO Fish.tech.Pap., (71):80 p.
Fishermen and the weather

Meteorology. Sea observations.
Instrumentation. Data reporting.

CONTENTS

Page

1 INTRODUCTION 1

1.1 Weather and fishing 1

1.2 Weather factors affecting fishing operations 1

2 SOME ELEMENTARY KNOWLEDGE OF WEATHER 3

2.1 What makes the weather 3

2.2 Clouds 4

2.3 Pressure 6

2.4 Wind, wave and swell 9

2.5 Precipitation and bad weather 15

2.6 Fog 16

2.7 Ocean climate 17

2.8 Tropical depression, tropical cyclone and strong monsoon 18

3 HOW A WEATHER BULLETIN IS PRODUCED 28

3.1 Weather map 28

3.2 Forecasting 29

4 HOW TO MAKE USE OF WEATHER INFORMATION 30

4.1 Weather information by newspaper, radio and television 30

4.2 How the weather information is relayed to fishing vessels 31

4.3 How to interpret weather information in conjunction with fishing operations 42

4.3.1 Avoiding storms 42

4.3.2 How to utilize the sea surface temperature for fishing operations 44

4.3.3 Some tips on forecasting weather without assistance 46

CONTENTS (Cont'd)

Page

5 METEOROLOGICAL OBSERVATIONS AT SEA 47

- 5.1 Instruments 47
- 5.2 Barometer 48
- 5.3 Wind vane and anemometer 49
- 5.4 Temperature 58
- 5.5 Visual observation 60

6 HOW TO REPORT WEATHER DATA FROM FISHING VESSELS 60

- 6.1 Code form. Abbreviated explanation of the code form SHRED 60
- 6.2 Where should the code be sent? Explanation of the columnar arrangement of the information on coastal radio stations accepting ships' weather reports 67

7 CONCLUSION 72

APPENDICES 73

- 1 Some technical words used in weather bulletins 73
- 2 Weather reports from ships in "sparse" areas 78
- 3 References 79

PREFACE

It is FAO's hope that this booklet will help fishermen to understand both meteorological principles and the value of meteorology in their profession, will encourage the cooperation of fishermen in the collection of weather data by national meteorological agencies under the international arrangements for which WMO is responsible, and will promote cooperation between operators of fishing fleets and World Weather Watch (WWW). The timing of publication is particularly appropriate as the World Meteorological Day (23 March) will, in 1968, be devoted to the theme "Meteorological and Agriculture".

The scientist mainly responsible for preparing this booklet was Dr. K. Terada*. He has been Chairman of the Working Group on Weather Advice for Fishing Operations of the Commission for Maritime Meteorology (CMM) of the World Meteorological Organization (WMO). One of the tasks of this Working Group, which was established at the Third Session of CMM, was to prepare "an outline of a booklet of instructions and advice to fishermen about the making and transmitting of meteorological observations and the proper use of weather information made available to them, with a view to national meteorological services preparing detailed instructions". The Working Group formulated an outline and submitted it in a report to the Fourth Session of CMM, which noted it.

This matter was also considered by the Second Session of the FAO Advisory Committee on Marine Resources Research (ACMRR) in February 1964. The ACMRR recommended that a model booklet should be prepared to assist Member Nations in drafting their own booklets, and in certain cases to be used in the interim. The ACMRR also recommended that a similar booklet be produced on oceanography for fishermen. These recommendations were brought to the attention of the Fourth Session of the CMM.

The first draft of the booklet was distributed for comment to members of the ACMRR and of its relevant Working Parties, to experts who had been members of the CMM Working Group, to the other UN Agencies concerned, to Regional Fisheries Councils and Commissions and to selected individual experts. Comments received with respect to both the general arrangement and the draft booklet have been considered in preparing a revised draft.

The revised draft was distributed for further comments, especially by experts associated with the WMO/CMM, on the basis of which this version was prepared for issuance in the official languages of FAO. Any eventual revisio to be prepared for publication in more appropriate format, would be made in close consultation with WMO. It should be noted that to meet the purposes for which FAO prepared the present version it was not possible to adhere strictly to the table of contents nor fully to the recommendations made by the CMM on the production of this type of booklet.

---

* Dr Terada, at the time of preparing the draft, was on the staff of FAO as Fishery Oceanographer, Fishery Resources and Exploitation Division, and is at present Director, National Research Center for Disaster Prevention (Japan).

Our thanks are due to WMO for the assistance received at various stages of this project, and to all those who made helpful comments on the drafts of the booklet, and especially to: Dr. M. Blackburn, Mr. A.B. Crawford, Dr. C.E. Lucas, Mr. D.L. McKernan, Dr. A.W.H. Needler, Mr. J.G. Cottis and Mr. S. Gadish.

Thanks are also due to Mr. G. Verploegh who assisted with the final revision and editing of the text, and to many agencies and publishers who have kindly given their permission for inclusion of certain figures and photographs.

S. J. Holt
Director
Fishery Resources and Exploitation Division
Department of Fisheries

1 INTRODUCTION

1.1 Weather and fishing

Many of man's activities are directly or indirectly related to weather conditions, and fishing is particularly affected by the weather. Fishermen know from long experience the effect of weather on fishing. In certain fishing grounds, for example, good fishing is expected when there are strong northerly winds, while when mountains are covered by thick clouds the fishing deteriorates. Knowledge of this relationship between weather and fishing has been gained through long experience in coastal fishing.

Fishermen sometimes operate far from coastal areas, often more than one or two days. Here the land is out of sight and the fishermen can no longer judge the weather by changes in clouds over mountains, or other familiar signs. Attempts to predict the weather over the open sea involves much guesswork and a wrong guess can easily lead a boat into severe or dangerous weather. Radio weather reports have improved this situation but the speed of a fishing boat is still much slower than the speed with which weather conditions can change. Thus, although the fisherman is warned of an approaching storm, he has not enough time to avoid it.

Since the Second World War, due to the rapid advance of naval architecture gear and techniques, there has been a development from coastal to pelagic and ocean-going fishing. Consequently fishermen operate over the ocean far beyond territorial waters and beyond the reach of normal radio waves for weather forecasting. Moreover, they may stay at sea even more than a month. Generally, such fishing boats are equipped with wireless receiving and transmitting apparatus, and the fishermen can contact fishing ports or coastal radio stations. In order to afford reliable weather information for fishermen the weather service should pay considerable attention to weather analyses over fishing grounds. Therefore in order to analyse the weather over fishing grounds, data obtained by fishing boats are very helpful to weather services in every country. Recently such fishing boats have begun to submit data to weather services for the mutual benefit of weathermen and fishermen.

Fishing operations should be considered from both the meteorological and economic points of view. There may be good stocks of fish in certain areas but, if bad weather prevails, these areas may not necessarily be good fishing grounds. Other areas less rich in fish may provide more economical fishing simply because of good weather.

1.2 Weather factors affecting fishing operations

Fishermen have to operate under various weather conditions and it is therefore very important for the fishermen to have knowledge of weather factors which directly affect fishing operations.

Coastal fishing operations are affected by the weather, but the weather plays an even more important role in pelagic or ocean-going fishing, and such fishing is ocean-wide.

Therefore the weather services of various countries should pay more attention to broadcasting suitable weather information for the benefit of fishermen. Generally, the most important elements of weather for fishermen are fog, ice, wind, waves and swell, both for coastal and pelagic operations.

It is often said that fog is the fisherman's worst enemy, worse for him than it ordinarily is for the merchant sailor because a fisherman has to make his living by putting nets and lines into the sea. Trawls may be towed half a mile astern, Danish seines may have 2 1/2 miles of rope and a net on the sea floor; Furthermore, fishing boats tend to concentrate on fish, so the chance of fouling or losing gear is greatly increased by fog.

Fog may also determine fishing technique. In foggy weather less light enters the sea and the redfish, for example, rises higher off the bottom than in clear weather. Therefore thick fog reduces catches of redfish by bottom trawl.

At night in thick fog the herring comes nearer to the surface than if there was good visibility, a cloudless sky and full moon. This difference in the vertical distribution of herring must be taken into consideration by an experienced fisherman when he chooses the length of the strops in drift net fishing.

The formation of ice deposit (ice accretion), particularly black ice, is another hazard in some fishing areas. Ice accretion hinders gear. Sometimes the boat becomes top-heavy and difficult to manoeuvre.

During winter, sea ice makes fishing operations extremely difficult. Some countries effectively forecast sea ice formations for the coastal fishery.

Some straits and headlands which fishing boats have to pass are notorious for the sea conditions that can be set up by converging waves from many directions and by the inter-action of waves and a strong tide.

Salmon fishing in the North Pacific begins by lowering the fishing nets approximately two hours before sunset, and they are hauled from midnight until dawn. One fishing net weighs 23 kg and is 58 m in length. About 300 of these nets are lowered from each boat, and when lying on the water look like one long net of approximately 15 km, around which the fishing boats sail. The net is sometimes cut down due to too much strain caused by wind and swell. Therefore strong winds blowing during the night or heavy swells in the direction perpendicular to the direction of the lowered set of nets can cause the fishermen a great amount of anxiety.

On every ocean fishermen have had similar experiences, and know only too well how fishing operations are affected by rough seas.

Air temperature is very important for agriculture, but usually has no direct effect on fishing, although it can be a main cause of formation of dense fog or ice, each presenting a serious hazard. However, eventually such bad weather frequently causes serious hazards to fishermen. Sea surface temperature is as important to fishermen as air temperature is to farmers. Similarly rain is not as critical a problem for fisheries as for agriculture. The duration of sunshine is closely related to agriculture, while it is generally negligible in fishing except for some coastal grounds.

After the war in several places (such as off the shores of Japan), the commercial pelagic fishing by attraction with artificial light became widespread. Weather again exerts its influence since on a cloudless night under a full moon, fish such as Pacific saury do not respond so actively to a light source.

Now we will confine ourselves to describing weather elements which are closely related to fishing operations in the following sections, omitting general meteorological descriptions on many elements and phenomena.

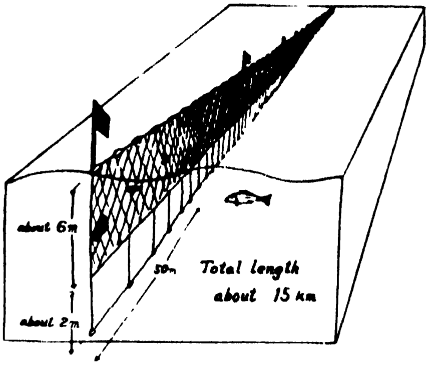


Fig. 1

2 SOME ELEMENTARY KNOWLEDGE OF WEATHER

2.1 What makes the weather

The earth receives heat from the sun during the day time and loses heat during the night. Over the ocean a considerable part of the sun's radiated heat is used for the evaporation of sea water without actually warming the water, while over land almost all the sun's radiation is used to warm the soil. Therefore during the daytime the land surface generally becomes warmer than the sea surface, while during the night the soil surface loses more heat than the sea surface. A similar situation is seen over continent and ocean. Continents become warmer than oceans in the summer; in winter the situation is reversed.

Heat from the sun is stronger in the equatorial regions than in the polar regions. The atmosphere near the equator becomes warm, expands and rises. In the polar regions the atmosphere cools and contracts and it moves towards the equatorial regions, counteracting the upward movement of the atmosphere in that region. This atmospheric movement is deflected by the effect of the rotation of the earth. The movement of air becomes even more complicated due to the air passing over the irregular pattern of the earth's land and water with the many differences in heat absorption and reflection.

The atmosphere is constantly circulating around the globe. In the equatorial region the east wind predominates; in middle latitudes of both hemispheres the strong westerly wind prevails. This general feature may be subject to local change and we therefore experience various kinds of weather in every part of the world.

The atmosphere contains water vapor which plays a very important role in weather. Generally, the amount of vapor included in air diminishes according to the altitude from the earth's surface, but water vapor cannot be seen. We notice it only when it takes the form of a cloud or a fog. Cloud or fog is formed when the air falls to a certain temperature and the water vapor in it condenses. Such a change of air temperature causes a change of weather, including the formation and dissipation of cloud.

2.2 Clouds

Clouds give us the simplest indication of weather. Each cloud is formed by water droplets or ice particles. Cloud formation is nearly always related to the upward motion of the air. When air rises its temperature decreases and the lower temperature causes the water vapor to condense, forming small water droplets. Thus condensation is directly related to the water vapor content of the air. There is usually a much higher water vapor content in the lower atmosphere since it is supplied by the sea surface and other water areas. This is why high altitude clouds are thin and those at a lower level are usually thicker, appearing dense and grey.

In meteorology the classification of clouds is rather complex, but generally they may be divided into four classes; high, middle and low altitude cloud, and vertically extending cloud.

The thin white clouds which seem motionless are located at a high altitude, about 8,000 meters or more (high altitude cloud). The rather thick, white or grey-white clouds covering the wide expanse of sky are generally located at middle altitude, i.e. higher than 2,000 m, and may partly consist of ice particles (middle altitude cloud). The thick blackish clouds are lower and may bring rain; they consist of water droplets and are in continual movement, changing form (low altitude cloud).

On sunny days we frequently see various kinds of cotton-like white clouds scattered in the blue sky, but these clouds (known as Cumulus), which also change form quite rapidly, do not generally bring rain.

We may sometimes see very large clouds of the same nature extending to the upper atmosphere, sometimes reaching 10,000 m or more. These are called Cumulonimbus. They are frequently accompanied by heavy rain and thunderstorm

The upper strata of Cumulonimbus consists of ice particles and there is strong upward and downward air movement. This cloud is carried from one zone to another by the movement of the upper air and continually changes form, developing with heavy rain and thunder and then gradually disappearing. Sometimes fishermen notice such a cloud over the ocean, generally accompanied by a heavy squall. When they notice continuous Cumulonimbus clouds over the western sky, in the middle latitudes, inevitably heavy wind, growing waves and rain follow within several hours.

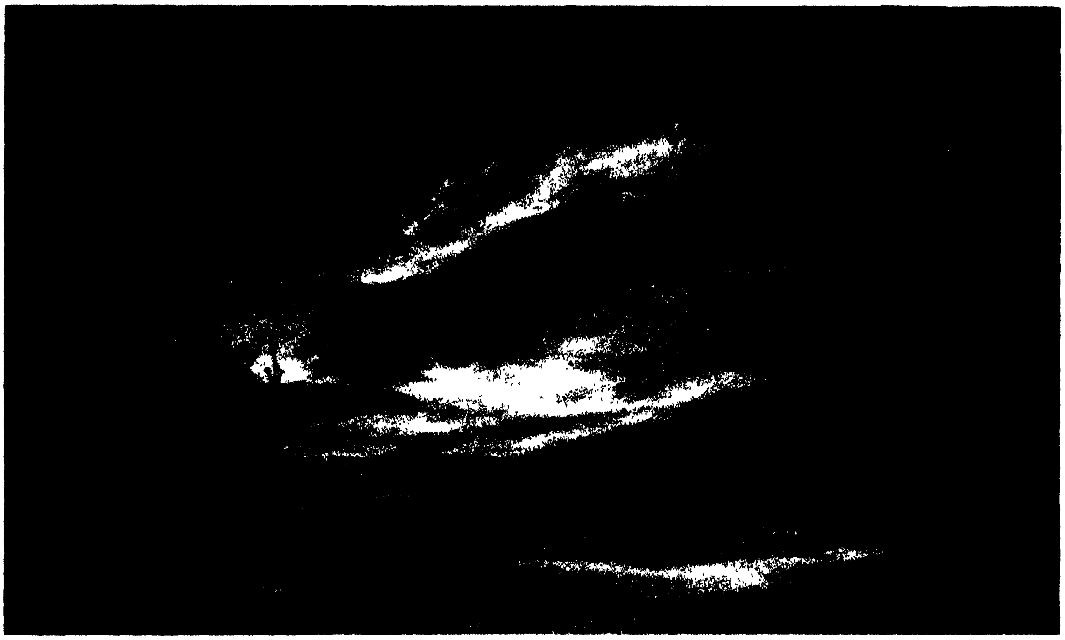


Fig.2a Cirrus in hooks and filaments
(From WMO International Cloud Atlas)

Fig.2b Cumulus with vertical extent
(From WMO International Cloud Atlas)

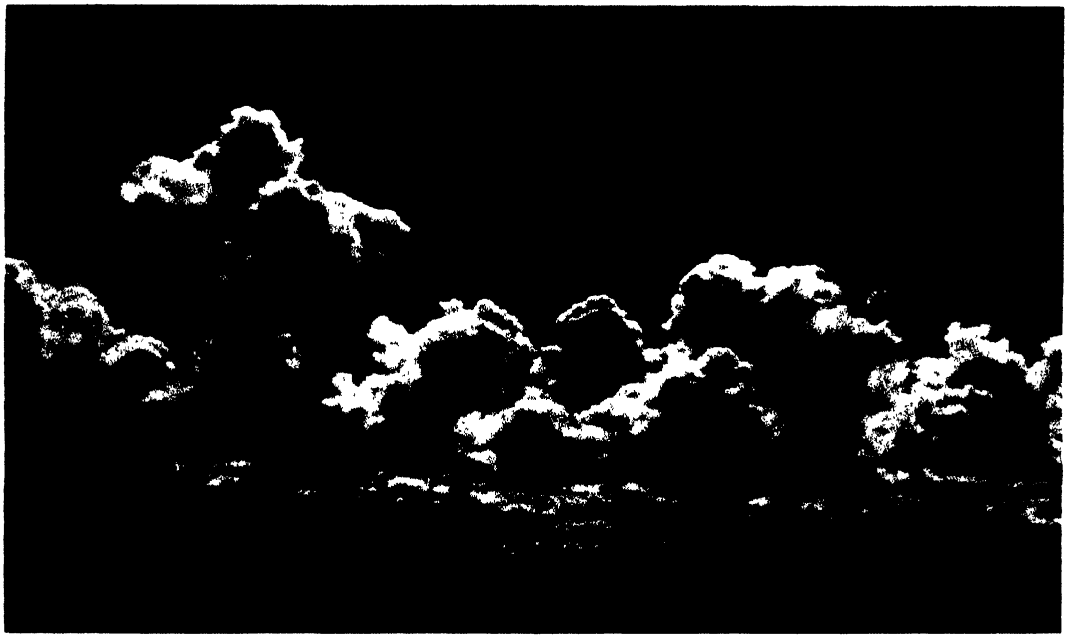


Fig.2c Altocumulus
(From WMO International Cloud Atlas)

2.3 Pressure

We know that the pressure of the atmosphere corresponds on an average to the weight of a column of mercury 76 cm in height at sea level. This has been shown by Torricelli's experiment. He took a glass tube, about one meter long, sealed at one end, and filled it with mercury. He then held the inverted tube in a dish of mercury, placing his thumb tightly over the open end to seal it. He found that, when he removed his thumb, the level of mercury in the tube went down and remained at a constant height of 76 cm. What is left in the upper part of the inverted glass tube? This is a vacuum, which in Torricelli's day was thought impossible, due to Aristotle's lingering influence.

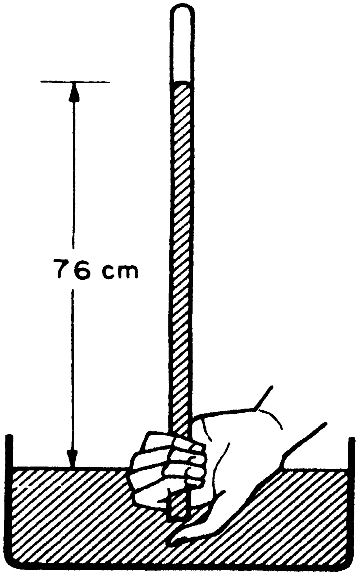


Fig. 3

Thanks to his experiment and Pascal's similar experiment, scientists were able to conceive that "atmospheric pressure" has power to push mercury up to a height of 76 cm into a vacuum. This implies that the atmospheric pressure corresponds to the weight of mercury. This value is called the pressure of "one standard atmosphere".

The atmospheric pressure is the result of the earth's gravitational force pulling all air particles, it corresponds to the total weight of atmosphere from the earth's surface to the top of atmosphere. This total weight corresponds to the weight of 76 cm of mercury. It is only out of necessity that we now introduce some mathematical calculation which is most important, and we trust you will be patient with us.

If we consider the mercury tube has uniform inside dimensions throughout its length and that the area of the mouth is one square centimeter, then the total weight of mercury in this tube is obtained by the mathematical calculation of the total volume multiplied by the density of mercury, thus:

Total volume		Density of mercury		
76 x 1 x 1	x	13.6	=	1,033.6 grams

We then see that the total atmosphere above the surface of the mercury in the dish is pressing down on every square centimeter of this surface with a weight of 1,033.6 grams. If the weight of an atmospheric column is calculated on the basis of one square meter, it would be nearly ten metric tons.

Pressure is a kind of force acting on a surface. (The above value of 1,033.6 grams is a weight, not a force). In order to convert weight to force it is necessary to multiply the acceleration of the earth's gravity - expressed by a letter 'g'. This acceleration varies slightly from place to place but is very near to 980 cm/sec^2.

The next calculation is then necessary:

1,033.6 x 980 = 1,012.928

When we multiply the weight by the acceleration, the result is expressed in terms of a unit called the "dyne"*. This value above is nearly equal to 1,000,000 dynes and this equals one "bar". For routine use it would be preferable to use the basic "millibar", i.e. 1,000 dynes. The above value is then 1,012.928 millibars, abbreviated to 1012.9 mb. The "millibar" is the unit commonly used in meteorology for indicating the atmospheric pressure.

This is a lengthy and annoying calculation but please make special note of the following points:

the pressure of "one standard atmosphere" is 1013 millibars (mb).

The atmospheric pressure decreases with height. Near sea level a pressure change of one mb corresponds to a difference in altitude of about 8 meters.

It is therefore necessary to compare pressure readings taken at the same level.

* 1 dyne is the unit of force which accelerates a mass of 1 gram by 1 cm per sec per sec.

At greater altitudes the atmospheric pressure decreases more slowly with height, because the air gradually becomes less dense. For example, the pressure of 500 mb, which corresponds to nearly half the weight of the entire atmosphere, is found at the altitude of approximately 5.5 km. Charts showing temperatures and winds at this level are important means for studying and forecasting the general development of weather systems.

Since knowledge of weather distribution requires sufficient informatic on the distribution of pressure at the same level, one standard level that we use is the average level of the sea. Instruments which are used on board ship to read the air pressure - aneroid barometer, barograph - are already adjusted to indicate, at the site where the instrument is installec the atmospheric pressure at standard level.

Weather stations on land are located at various altitudes but since pressure is affected by difference in altitude, meteorological pressure readings for use in weather maps should be corrected to the value at sea level. Such corrected values are used for weather analysis.

The above description may lead one to believe that atmospheric pressu only acts vertically to the earth's surface. This is not so. Pressure of air or water should act in every direction, not only in the vertical but also in the horizontal direction, and even obliquely. When there is no atmospheric movement on the earth, the atmospheric pressures in all directions are equal. If this equilibrium is broken, this unbalanced force is the origin of air movement, i.e. the wind.

Generally, atmospheric pressure changes according to time, and in order to compare the atmospheric pressure at two points we must observe the pressure simultaneously.

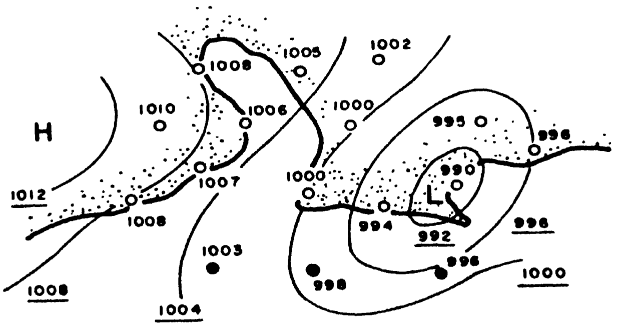


Fig.4- Isobars are here drawn at every 4 mb, such as 1012,1008,1004 et but any convenient interval may be used.
H = High pressure area L = Low pressure area
o = Observation on land.Pressures are corrected to the value of that of sea surface
= Observation on board ship

If we were to plot surface pressure readings at various points made at a fixed time, on a blank map, we would find that some areas show a high value and others a low value. To clarify this feature we should draw a line, connecting certain pressure points of the same value. These lines are known as isobars, and by drawing isobars on a blank map we may easily distinguish areas of high and low pressure.

2.4 Wind, waves and swell

Wind is the movement of air. This movement is caused by the horizontal difference of atmospheric pressure. The larger this difference is over a unit of distance, say 60 nautical miles, the stronger is the wind. This feature is shown on a weather chart by the fact that a narrow spacing of the isobars corresponds to strong winds while an open spacing generally corresponds to light winds. Storm areas are therefore identified on a weather chart by areas where the distance between consecutive isobars is comparatively very small.

We must bear in mind that the relation between the wind speed and the distance between isobars on a weather chart also depends on the geographical latitude. Under the same distance between isobars the wind speed is stronger at low latitudes than at high latitudes. The curvature of the isobars is another important factor to consider. When the isobars are strong curved around a centre of low pressure, the wind speed will be smaller than the speed which corresponds with straight and equally spaced isobars. Reversely, when the isobars are strongly curved around a centre of high pressure, the wind speed will be greater than the speed which corresponds with straight and equally spaced isobars. Meteorologists make use of specially constructed wind scales to read the wind speed from a weather chart on the basis of the spacing and the curvature of the isobars, taking into account the latitude.

Since the horizontal difference of atmospheric pressure causes the wind to blow, one would think that the wind blows over the earth's surface from high pressure to low pressure, that is straight across the isobars. This would be true if the earth were not rotating. In reality the earth's rotation causes the wind to deflect, towards the right in the northern hemisphere and towards the left in the southern hemisphere. The way in which the wind is actually blowing is shown in Figs. 5-8.

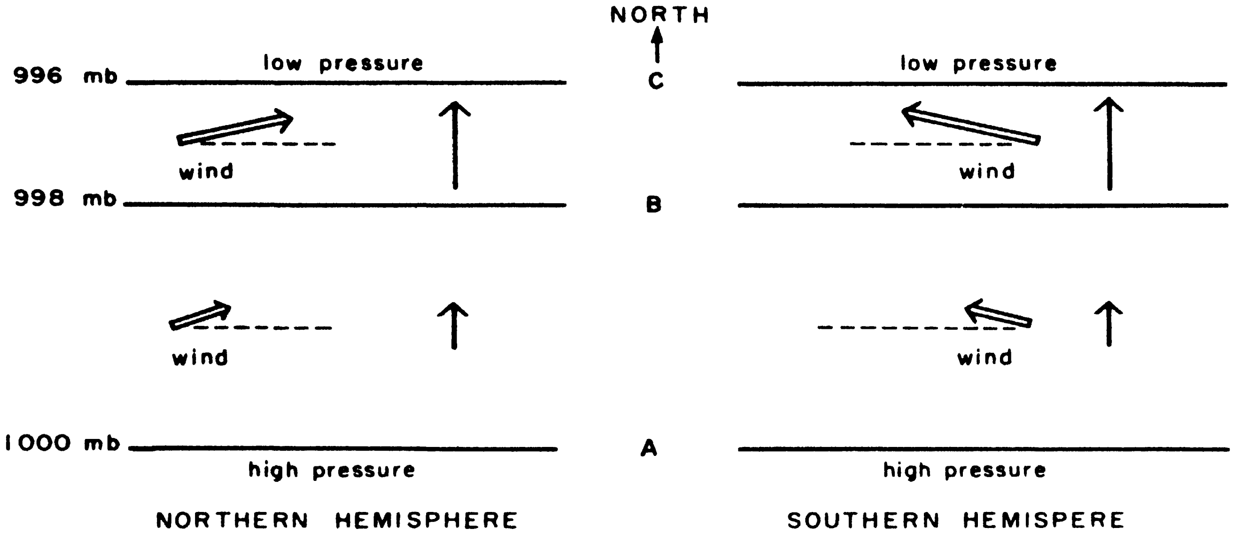


Fig. 5 The distance of the isobars, at 2 mb interval, between A and B is twice as large as the distance between B and C. Consequently the driving force of the wind, due to the horizontal pressure difference (single arrow), is between A and B twice as small as between B and C. Similarly, the wind speed (double arrow) between the places A and B will be twice as small as compared to the speed of the wind between B and C. Wind directions apply for conditions found over sea areas.

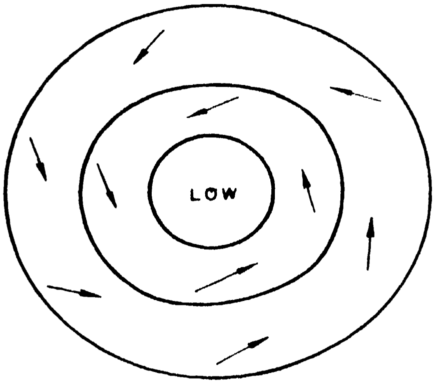


Fig. 6 Anticlockwise movement of the wind around a centre of low pressure in the northern hemisphere.

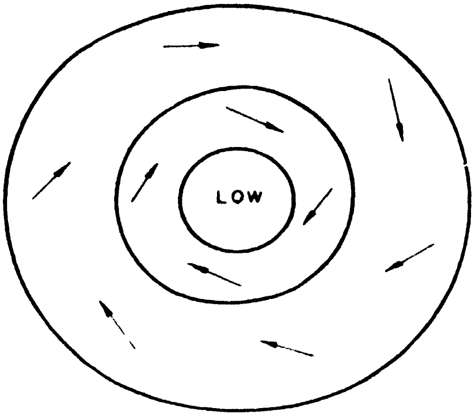


Fig. 7 Clockwise movement of the wind around a centre of low pressure in the southern hemisphere.

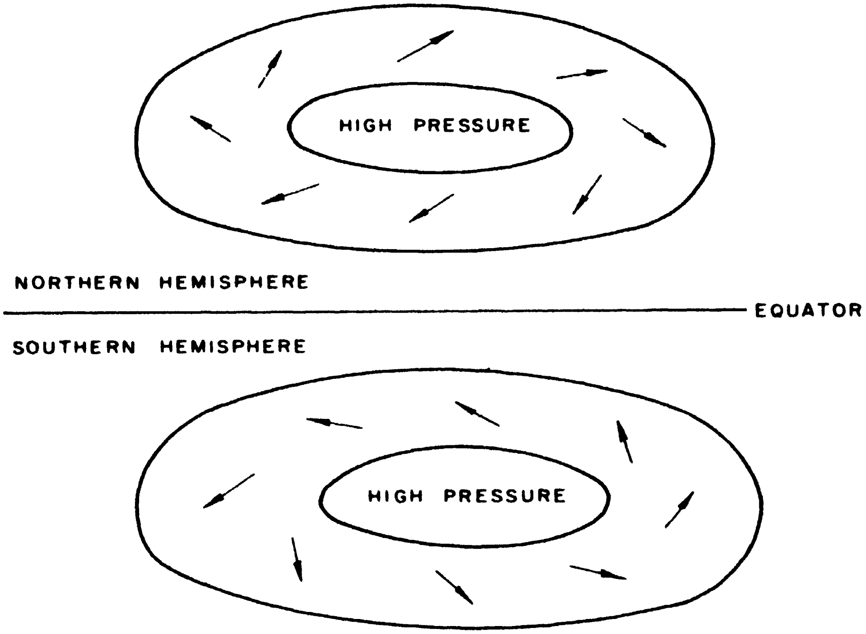


Fig. 8 Movement of air around a centre of high pressure (anticyclone), in the northern and in the southern hemispheres.

The inclination of wind is mostly affected by the friction of the earth's surface and the friction of the continental area is greater than that of the ocean. In fact wind direction is inclined 10°-30° to the isobar in the oceanic area and by 30°-50° in the land area. If friction is zero, wind should blow parallel to the isobar due to the effect of the earth's rotation.

The above description illustrates only average wind conditions. If we record the data of wind speed and wind direction, we notice that the structure of wind is very complex. Fig. 9 shows an example of a wind trace from an anemograph, an instrument which continuously records wind speed and direction. Wind is blowing from an easterly direction with average speed of 5 m/s, the speed becomes greater after 2 hours, then abruptly the direction and wind speed change to north and 15 m/s respectively, but sometimes the speed exceeds 20 m/s. It should be noted that although the weather services may announce the speed of wind as 15 m/s, stronger gusts of wind are naturally included in the expression of 15 m/s.

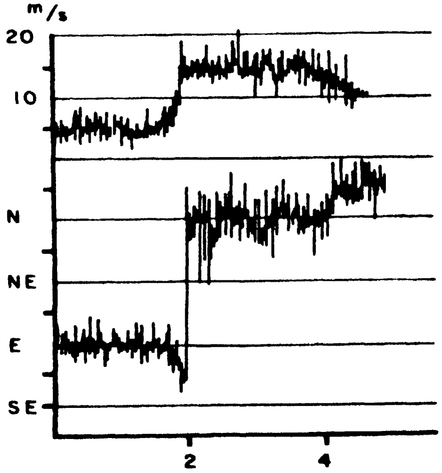


Fig. 9 An anemograph Recording

Wind speed is sometimes expressed by nautical miles/hour (knot) or km/h. For fishermen the unit knot is perhaps more familiar than m/sec. The following table gives the conversions. Roughly, speed in knots is nearly twice that expressed in m/sec.

Conversion of Meters per Second to Kilometers per Hour, to Statute Miles per Hour, to Knots

m/sec	km/hr	mph	knots	m/sec	km/hr	mph	knots
1	3.6	2.2	1.9	16	57.6	35.8	31.1
2	7.2	4.5	3.9	17	61.2	38.0	33.0
3	10.8	6.7	5.8	18	64.8	40.3	35.0
4	14.4	8.9	7.8	19	68.4	42.5	36.9
5	18.0	11.2	9.7	20	72.0	44.7	38.9
6	21.6	13.4	11.7	21	75.6	47.0	40.8
7	25.2	15.7	13.6	22	79.2	49.2	42.7
8	28.8	17.9	15.6	23	82.8	51.4	44.7
9	32.4	20.1	17.5	24	86.4	53.7	46.6
10	36.0	22.4	19.4	25	90.0	55.9	48.6
11	39.6	24.6	21.4	30	108.0	67.1	58.3
12	43.2	26.8	23.3	35	126.0	78.3	68.0
13	46.8	29.1	25.3	40	144.0	89.5	77.7
14	50.4	31.3	27.2	45	162.0	100.7	87.4
15	54.0	33.6	29.1	50	180.0	111.8	97.1

Sea waves which are generated by the wind have a characteristic appearance. The heights and the periods of the waves which appear within eyesight are very irregular.

Some definitions: wave height is the difference in height between the crest and the subsequent trough of a wave; wave period is the time difference between two consecutive wave crests passing a fixed point; wave length is the distance between two crests.

The irregularity of a train of sea waves passing a fixed point is illustrated in figure 10 which shows a record of the vertical displacements of a buoy floating at the sea surface. The record clearly indicates that when describing sea conditions, it is of no use to just mention the height of one single wave, we must make an average height and an average period. Observers are asked to estimate the average height of the higher and well-developed waves, so that about one out of 10 individual waves will be higher than the wave height which is reported. The observed height closely corresponds to the so called "significant" wave height given in weather bulletins and in forecasts. One may expect that one out of 10 waves may exceed the significant wave height by a factor of 1.5 at the most. Very occasionally a single wave may rise to twice the significant height. For example, if a significant wave height of 4 m is given, we know that a few waves may rise to 6 m, while one may, or perhaps may not, encounter a maximum wave of 8 m in the area.

The stronger the wind, the greater the significant wave height. The height of waves not only depends on the wind force, but also is limited by the duration of the wind of given strength and the wind fetch over wind sheltered waters. In the open sea the following conditions are encountered.

5 m/s wind generates waves with a significant height of 1 m or less
8 m/s " " " " " " " " 2 m " "
11 m/s " " " " " " " " 3 m " "
13 m/s " " " " " " " " 4 m " "
19 m/s " " " " " " " " 10 m " "

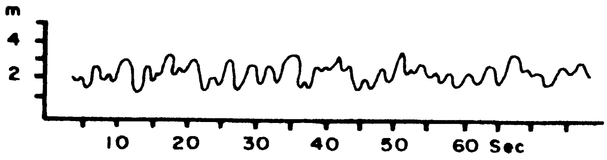


Fig.10 Record of the vertical displacement of a floating buoy.

For single waves the following table gives an idea of the relation between various wave elements.

Period(s)	wave length(m)	wave velocity(m/s)	wave height (m)
3	about 12	about 5	Less than 1
5	40	8	2
7	75	11	4
10	150	15	6

Sea conditions in coastal areas are often indicated in weather bulletins in terms of the state of the sea. These descriptive terms are well known to all seamen and fishermen, they generally refer to waves which are generated by the local wind in the area.

When sea waves run out of the area in which they were generated by the wind, they soon lose their irregular appearance. Now they become swell, regular waves with a smooth appearance, often with a long period and long wave length. The direction from which they come generally differs from the local wind direction. High swell which is generated in storms propagates over the ocean for long distances; the height of the waves gradually decreases as the waves become more regular and, often, longer.

When swell is observed in good weather conditions, it reveals the existence, one or more days earlier, of a storm (hurricane, typhoon, or a winter storm of middle or high latitudes) in the direction from which the waves arrive.

In bad weather conditions swell waves may arrive from the upwind section of the storm area, in that case they run nearly parallel with the local wind direction. Swell may also arrive from other storm areas in the same depression. Fishing boats are then likely to encounter a confused, irregular and sometimes dangerous wave pattern, consisting of wind waves often of severe intensity and a swell from a different direction (confused seas).

2.5 Precipitation and bad weather

A low pressure area is often associated with bad weather. Such areas are shown on the weather map as areas enclosed by isobars of increasing value (in mb). They are called lows or depressions. The weather over the area often exhibits two lines or zones of bad weather. One is found in the forward part of the depression and is called the warm front; the other is found at the rear end of the depression, and is called the cold front. In the northern hemisphere there is a flow of warmer air from the south over the colder air, which causes a weak upward motion. This phenomenon is seen in almost all areas along the warm front. As this warm and humid air from the south rises, it condenses and various types of clouds will bring light rain, which may last for some time. At the cold front, the cold air undercuts the warm air and forces it to rise: Cumulus and Cumulonimbus clouds are formed and there may be a thunderstorm and accompanying heavy rain.

The above description is somewhat schematic, and in fact we encounter many variations on these general patterns.

The different heating of continents and oceans in summer and in winter has pronounced effects on the weather in tropical areas. In summer the continents become warmer and the humid air blows into the continents from the sea, which brings heavy rain in tropical areas. On the contrary the continents became colder in winter, and, with the high pressure area predominating, the winter monsoon blows continuously from inland. One example is seen in the East China Sea, which is stirred by the continuous monsoon wind. At its eastern end flows the warm Kuroshio current; this is a very strong current and its branches sometimes find their way into shallow sea areas where we find a great difference between sea surface and air temperatures. This causes a strong upward movement of humid air, especially when the cold wave from Siberia predominates, resulting in unexpectedly strong gusty winds which may sometimes cause shipwreck.

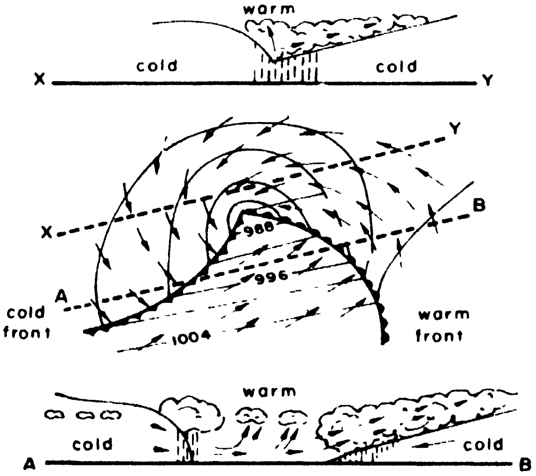


Fig.11 Depression and cross sections of its cloud structure in the northern hemisphere

Similar weather phenomena are frequently encountered when cold air from the continent blows over a warm ocean current. Cumulonimbus clouds are then formed, accompanied by heavy rain and thunderstorms. Owing to lack of sufficient oceanic weather data, meteorologists sometimes miss such weather phenomena which might result in unexpected disaster for fishing boats.

2.6 Fog

Dense fog hampers fishing operations. Fog is caused by tiny water particles at a low altitude, and the greater the concentration of these particles the less visibility we have. Fishing boats are frequently threatened with collision in dense fog and fishing operations become impossible.

Generally, fog is encountered where cold ocean currents predominate or come into contact with warm currents. When the air temperature is higher than the sea surface temperature, the resulting environmental condition is right for the formation of fog. This means that fog is more frequent during the summer. To give an example, the following weather charts (Fig.12) show a large area of foggy weather in the northwestern Pacific; we can see from the chart how a southerly wind blows over the northwestern half of the high pressure belt. The hatched area depicts the regions where fog is reported, while there is no fog in the southern area of high pressure.

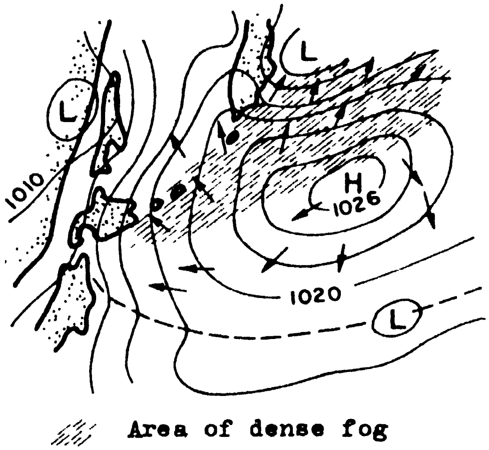


Fig.12 Foggy Area

It is therefore necessary to have some knowledge of the features of oceanic currents and distribution of sea surface temperature, in order to know about the formation of fog at sea.

Fig. 13 indicates the distribution of sea fog in the world during the summer. Sea fog is generally observed during spring and summer, when the temperature of air blown from adjacent land is higher than the sea surface temperature, and over the oceanic area, where warm and cold currents are in contact.

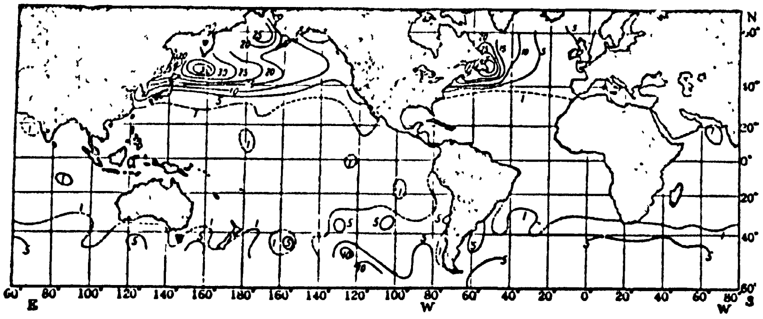


Fig. 13 Distribution of sea fog during the summer

One of the highest frequencies of foggy weather is near the Kurile Islands and off Hokkaido. The reason is that here the warm Kuroshio current meets the cold Cyashio current. A similar situation is seen off Newfoundland, where the warm Gulf Stream meets the cold Labrador current. We frequently observe sea fog off California. In Europe fog in the North Sea and Baltic Sea is generally caused when the warm air from the land blows over the sea.

2.7 Ocean climate

Weather conditions change from day to day. The average state of the weather is called 'climate'. So we may use such terms as the climate of January, summer climate, climatic change, etc.

There have long existed a considerable number of weather stations in the developed countries and, apart from a few areas, we are able to describe the climatic features over land. The climate of the oceans is known from the weather observations which seamen are used to record in their logbooks. Charts designed to provide or include information on ocean climate began to appear in the days of Columbus. During the first half of the 19th century efforts by individuals to compile more detailed information were initiated to meet the needs of maritime commerce. Mr. M.F. Maury, Officer of the United States Navy, was the most outstanding among those individuals. His chart was the beginning of the "Pilot Chart" for mariners. Since then several maritime countries, such as the United Kingdom, Netherlands, Germany, USA and Japan began to follow and expand his system. There are many useful maps for mariners. Recently, utilizing the electronic computer, some countries, such as the USA, USSR and others, began to compile very elaborate maps of ocean climate.

In the present time, the accumulation of data from ships has become extremely important in view of a quantitative clarification of oceanic climate and also the establishment of relationships with, for instance, fish abundance. Under the auspices of the World Meteorological Organization (WMO) an international scheme was set up to collect on a regular basis data from merchant ships, research vessels and fishing boats.

There is little variation over the ocean in radiation received from the sun. There are few differences in the type of atmosphere over the oceans For example, during summer a large part of the Pacific is influenced by homogeneous high pressure area and this weather pattern continues for a long time.

Part of the sun's radiation over the seas is used to evaporate water and part to warm water. Over land, solar radiation is used to warm the soil, to evaporate water (lakes, wet soils) and for the transpiration from vegetation. During summer the sea surface temperature is generally lower than the mean air temperature over adjacent land areas. There is a constant supply of humidity over the ocean caused by evaporation. If conditions are suitable for the formation of a low pressure area, a depression at low latitudes may well develop into a tropical cyclone.

Air temperature drops very low in winter in some areas, but sea temperature seldom falls below -1°C. The freezing point of sea water is lower than that of fresh water; the higher the salinity the lower the freezing point. Salinity is seldom high enough to depress the freezing point below -2°C which is about the lowest sea temperature found anywhere.

The high pressure region over the continents in winter produce a constant wind toward the ocean over large parts of the surrounding oceanic areas. This wind is known as the winter monsoon. The chart (Fig. 14) will show the wind frequency in the oceanic area during January. Winter winds are much stronger and more persistent than, for example, July winds (Fig.15). These winter winds may often cause damage to fishing boats.

One noticeable point is the constant wind over the tropical area. These are the "trade winds". They are the main origin of circulation of ocean current. Due to the existence of continents, the equatorial current thus caused is obliged to turn towards the poles, but in the southern hemisphere there is almost no land area from 40°S to 70°S, and a westerly wind blowing over this area causes a constant current flow around the Antarctic.

2.8 Tropical depression, tropical cyclone, and strong monsoon.

The equatorial ocean constantly received the solar radiation and frequently a weak low pressure area occurs there. Warm and humid air begins to converge on this area. Water vapor included in this convergent air condenses, forming clouds of a Cumulus or Cumulonimbus type. Due to the existence of an easterly air flow in the upper layers of the atmosphere this centre of low pressure moves westward over the tropical sea area and receives more and more energy, gaining considerable strength after several days. Thus the centre of low pressure may form a tropical depression, the maximum wind exceeding 30 knots. As long as the maximum wind force does not exceed Beaufort force 9, the depression is referred to in weather bulletins as a tropical depression. When maximum winds reach Beaufort force 12 (around 60 knots or more) the depression is called a tropical cyclone. The storm area of a cyclone is more than several hundred kilometers across. In the area of the depression, wind is converging to the centre in an anticlockwise direction in the northern hemisphere, (clockwise in the southern hemisphere) and a series of clouds, generally of Cumulonimbus type, are formed along the trajectories of converging wind (Fig. 16).

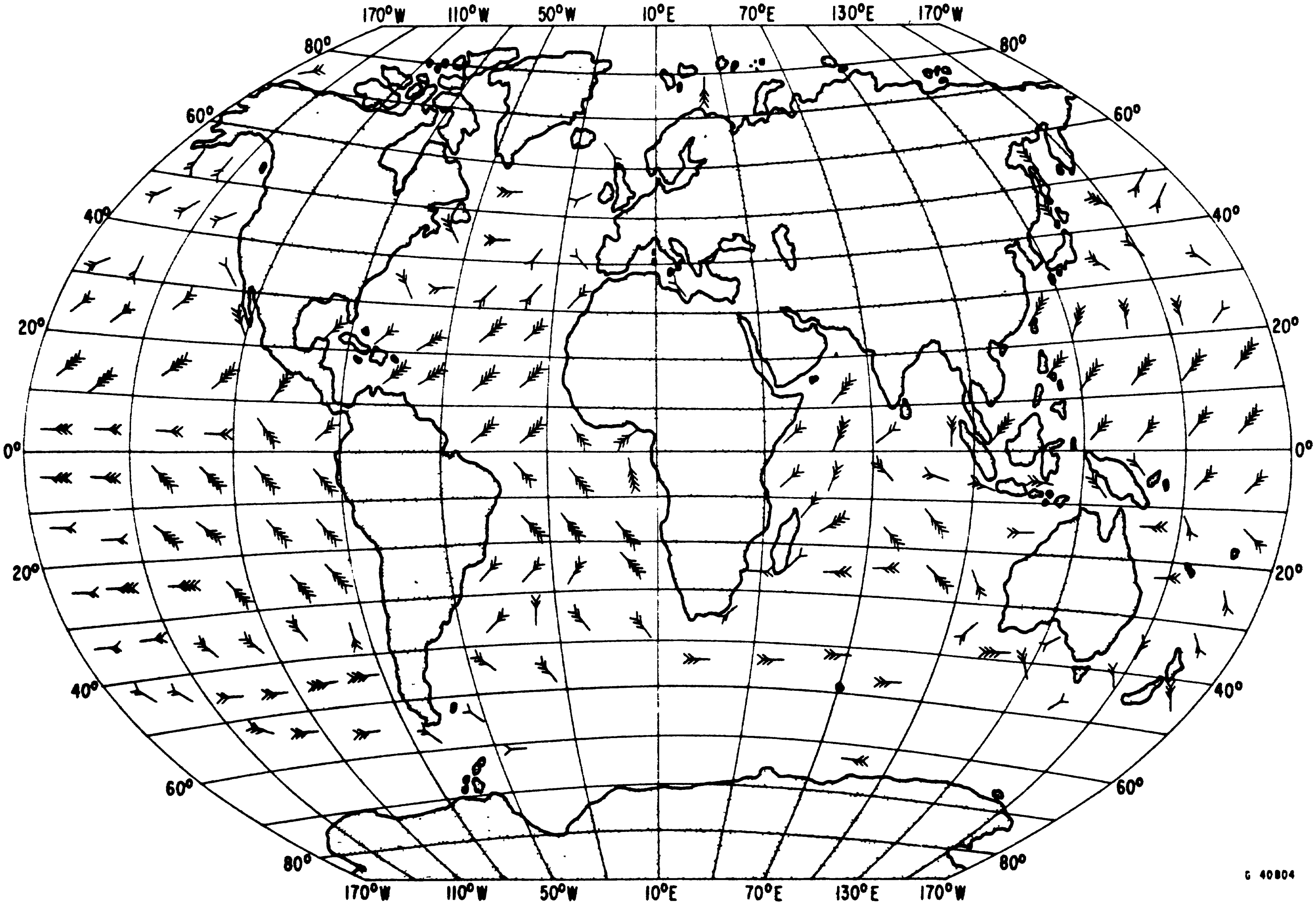


Fig. 14 Mean wind field, month of January. Arrows indicate directions of the most frequently observed surface winds. Barbs mark the frequency of the winds in percentage of the observations, each barb representing 10 per cent. Thus

west wind 20 per cent of observation: northeast wind 80 per cent of observations.

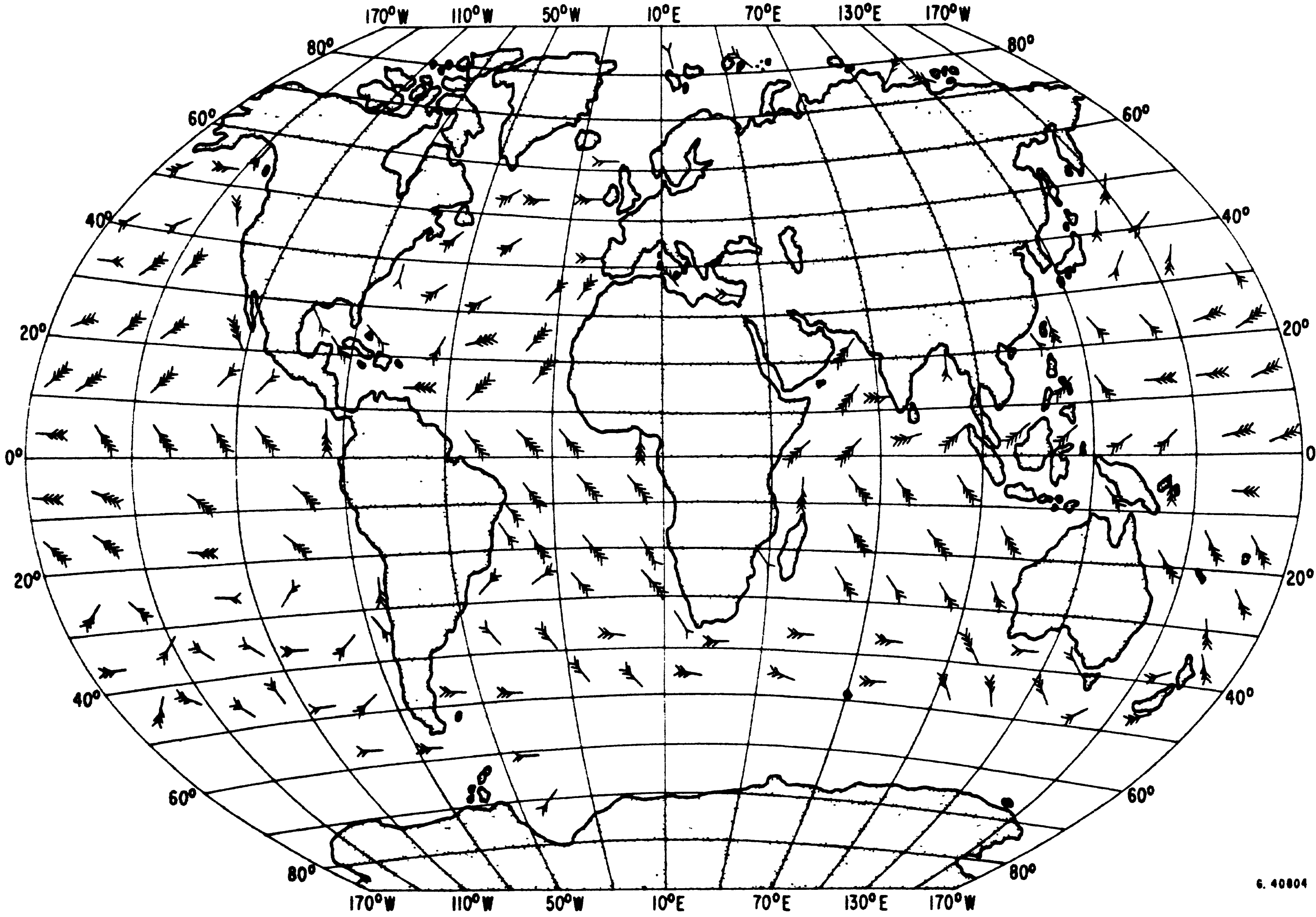


Fig. 15 Mean wind field, month of July. (Legend, see Fig.14)

Fig. 14 and Fig. 15 are modified from the charts of "Handbook of Meteorology" by Berry, Bollay and Beers. Copyright 1945. McGraw-Hill Book Company. Used by permission.

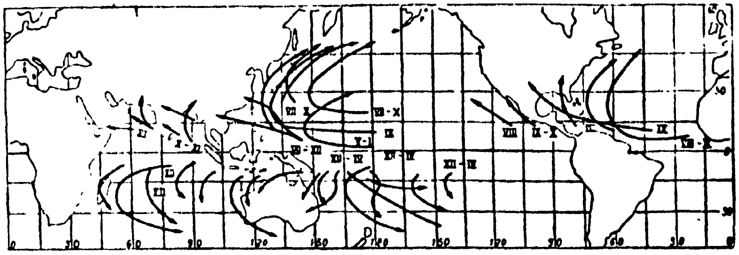


Fig. 16 General course of cyclones for each month

The intensity of a tropical cyclone sometimes develops greatly. The centre pressure may drop below 900 mb and the maximum wind may exceed 100 knots. Such a developed tropical cyclone is known as a hurricane in the Atlantic, a typhoon in the Pacific, a cyclone in the Indian ocean, and a willy-willie in ocean areas surrounding Australia.

Fishermen have on many occasions experienced the rapid development of a typhoon, which increases its radius of gale, thus causing a great increase in wave height. Consequently fishermen operating in areas where tropical depressions and tropical cyclones frequently occur should be made aware of this danger.

Tropical cyclones move at first at a speed of 8 to 12 knots from east to west. At their most westerly point, which is called turning point, "cod point", they turn poleward and later to the east. When about to turn, the movement of the cyclone often becomes erratic for a while. During this period, which may extend over several days, forecasting the cyclone's path becomes extremely difficult. Once the cyclone has curved poleward and toward easterly directions, it usually accelerates and gradually transforms into a normal "extra tropical depression" of great intensity.

Recently it has been possible to construct the whole picture of a strong hurricane or typhoon, with the aid of meteorological radar or from data received from artificial satellites, such as Tiros or Nimbus. The following figure shows the rain band of the hurricane Cleo, in 1964, as seen on the radar scope.

The pressure of a hurricane (cyclone or typhoon) becomes deeper and the wind stronger nearer the center but in the center there is a calm region called the "eye" which is easily recognized in the figure. When a ship is obliged to sail into the storm area of a hurricane the wind becomes much stronger as it approaches the center, and the ship is rolled by large waves more than 10 m high and heavy rain occurs almost continuously. On entering the "eye" the wind calms abruptly but the waves are of a very confused nature. After an hour or so, the ship suddenly receives the strong wind from the reverse direction which shows that it has entered into another semicircle of the hurricane.

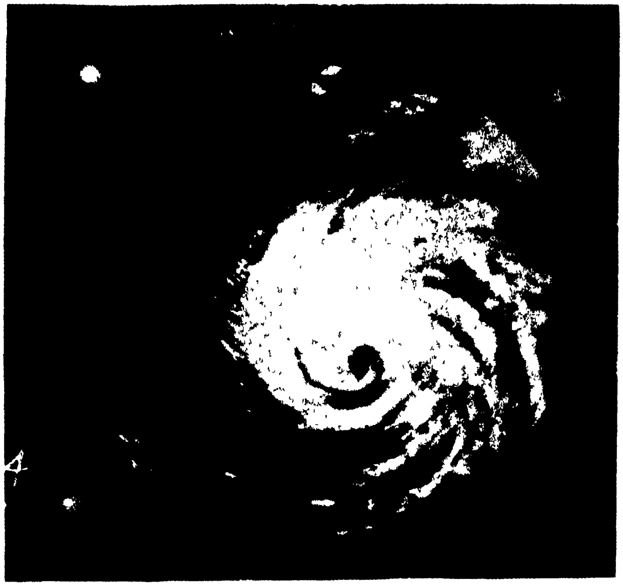


Fig. 17 Weather Bureau radar at 2315 EST.
26 August 1964, located eye of Cleo
about 25 miles southeast of Miami
(Courtesy of U.S. Weather Bureau)

In the northern hemisphere the right-sided semicircle of the hurricane, according to the direction of the hurricane's movement, should be avoided by ships. It is the side towards which the centre tends to curve before or when the hurricane has reached its turning point or little after. Ships which are forced to heave to in this semicircle run a risk to be approached too closely by the hurricane's centre.

In the southern hemisphere the left-sided semicircle should be avoided for the same reason.

On the other hand, the opposite semicircle to the dangerous semicircle is called the "navigable semicircle". However, even within this navigable semicircle a ship will of course be endangered if it comes close to the centre of a hurricane.

As an example a weather chart of typhoon Vera is shown. The typhoon moved westwards from the Marshall Islands and then turned northeast, attacking the central part of Japan. It was very strong, accompanied by a severe storm surge, and caused tremendous damage in the bay of Nagoya, and an adjacent port. Many fishing boats were wrecked together with cultivated sea beds, which greatly damaged the oyster and pearl culture industry. From the weather chart it may be inferred that the pressure in the centre was very deep, which is a sign for the existence of high wind speeds, especiall near the central part of the typhoon.

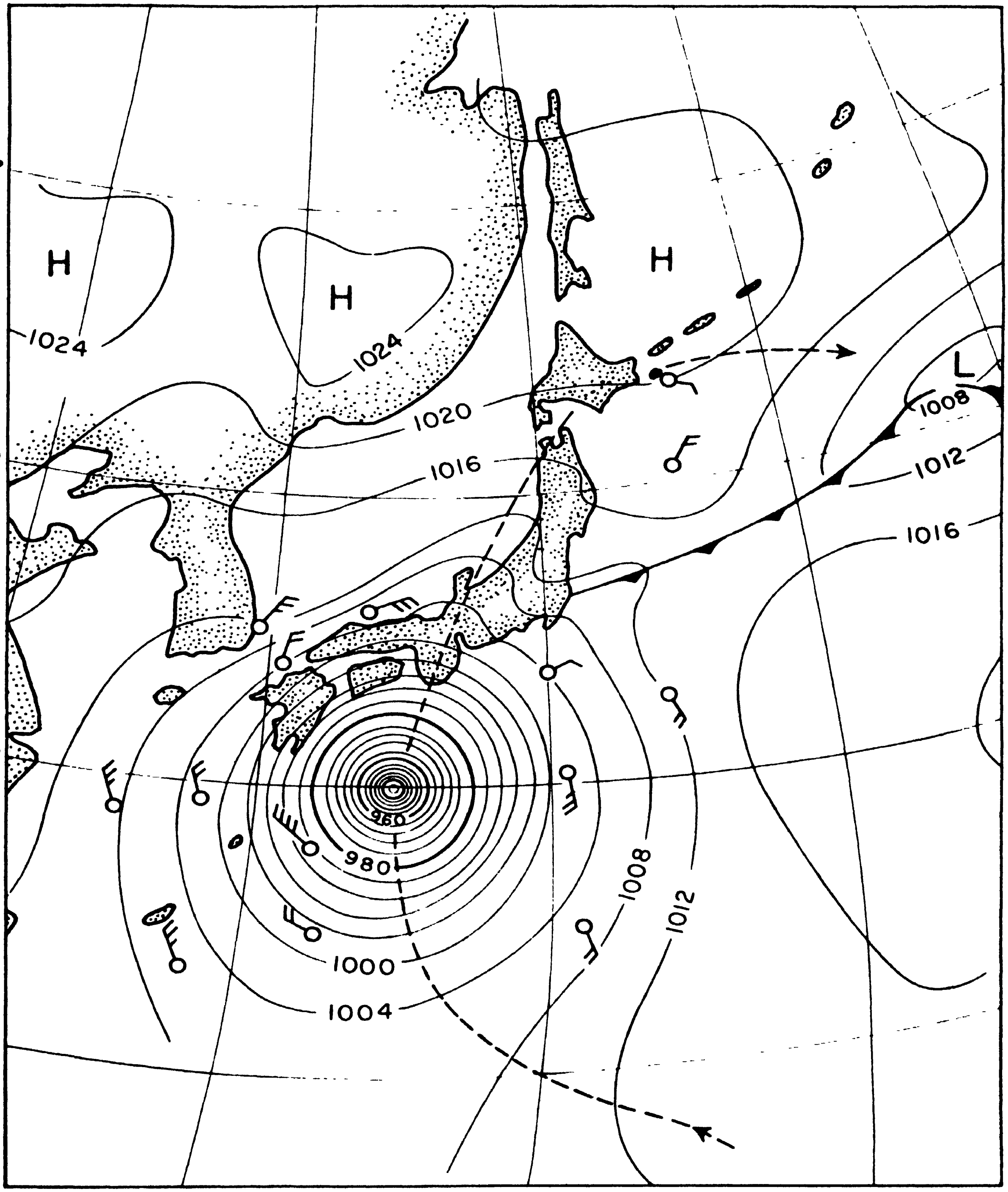


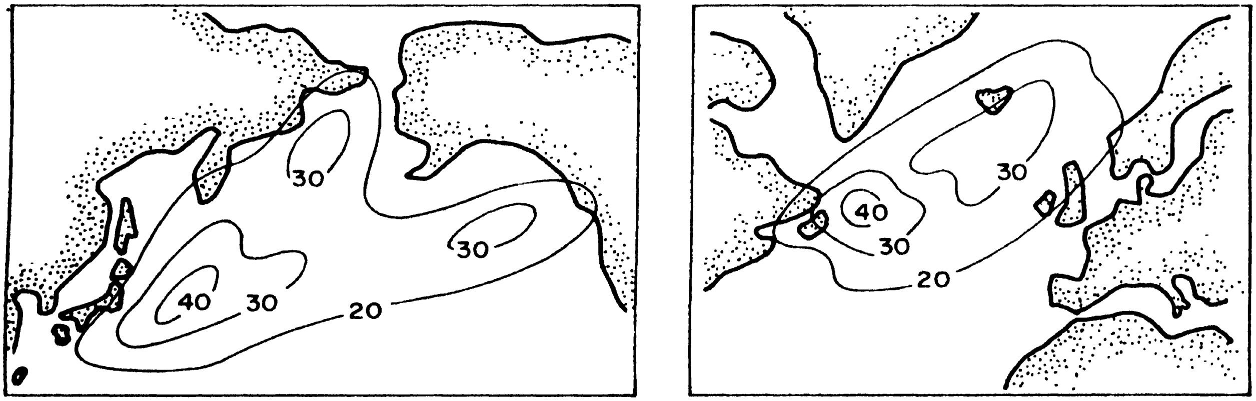
Fig. 18 Typhoon Vera. 00:00 GMT, 26 September 1959

On 16 December 1965 - the same day as Gemini 6 and 7 made their epoch-making rendez-vous in space - the newspapers reported that two thousand people died in a killer cyclone, which whirled through East Pakistan, devastating crops and villages. The press reported that:

"On Sonadia, one of the small islands dotting the Bay of Bengal, 200 deep-sea fishermen were reported missing. As many as 10,000 persons may have died when the 140 mile-per-hour cyclone tore through a 6,000 square mile area.

Most of the victims were said to have been killed by an accompanying tidal wave. Thousands of the victims were reported to be fishermen caught by the wave while at sea tending nets along the island-dotted coast.

Reports said warnings of the impending storm did not reach the inhabitants of the area in time".



PACIFIC OCEAN

ATLANTIC OCEAN

Fig. 19 Percentage of observations of wind stronger than 15 m/s (Beaufort force 7) (Winter Season)

In winter a high pressure area predominates over the continents and the monsoon prevails from continent to oceanic area. At the higher latitudes wind from the continent is very cold and dry and when passing over the ocean receives rather suddenly a considerable amount of water vapor from the sea surface, which sometimes causes the rapid development of a winter depression over the semipolar oceanic region. The most outstanding example of this may be seen in the northern Atlantic and Pacific oceans.

It should be noted that such a winter depression develops quickly and moves very rapidly, and the strongest wind is expected at the rear and not in or near the centre of the depression. The most famous depression of this nature is known as the "Aleutian low". It is sometimes more than 1,000 km wide. Many shipwrecks have occurred on the Aleutian fishing grounds.

Statistics show that in the winter monsoon season, vast oceanic areas are frequently subject to winds stronger than 30 knots. Such areas are generally far from land. The strong winter depression develops suddenly over these areas and moves rapidly. Thus, fishermen are sometimes unable to sail away from these vast stormy areas or to make sufficient preparations beforehand for stormy weather. Consequently, many lives are lost. Fig. 20 is an example of a weather map showing a very strong depression of the Aleutian low. We notice the comparatively small distance between the isobars just behind the depression. In this case many fishing boats were lost.

Fig. 21 is a weather map which shows areas of very rough seas over the whole North Sea. Northwesterly gales occur when a deep depression moves southeast across southern Norway and Sweden. With this movement, exceptionally high tides result along the North Sea coasts of Scotland, England, the Netherlands and northwest Germany. Fortunately, such a severe depression occurs very rarely in Europe.

However, although the Pacific and Atlantic weather maps show very similar wind strengths in each ocean, strong depressions occur regularly in the northwest Pacific, frequently damaging many fishing boats near Japan.

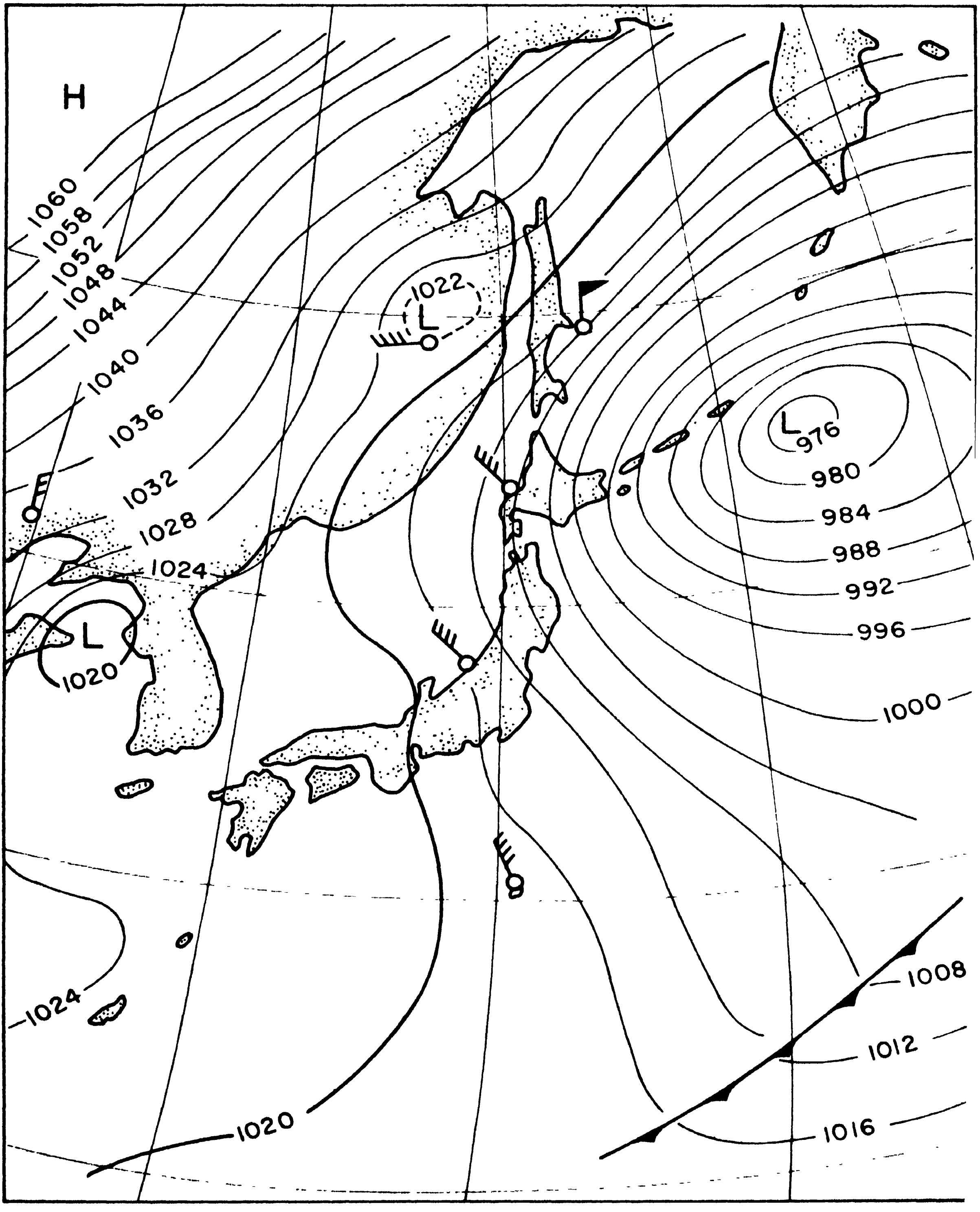


Fig. 20 0000Z 10 January 1965

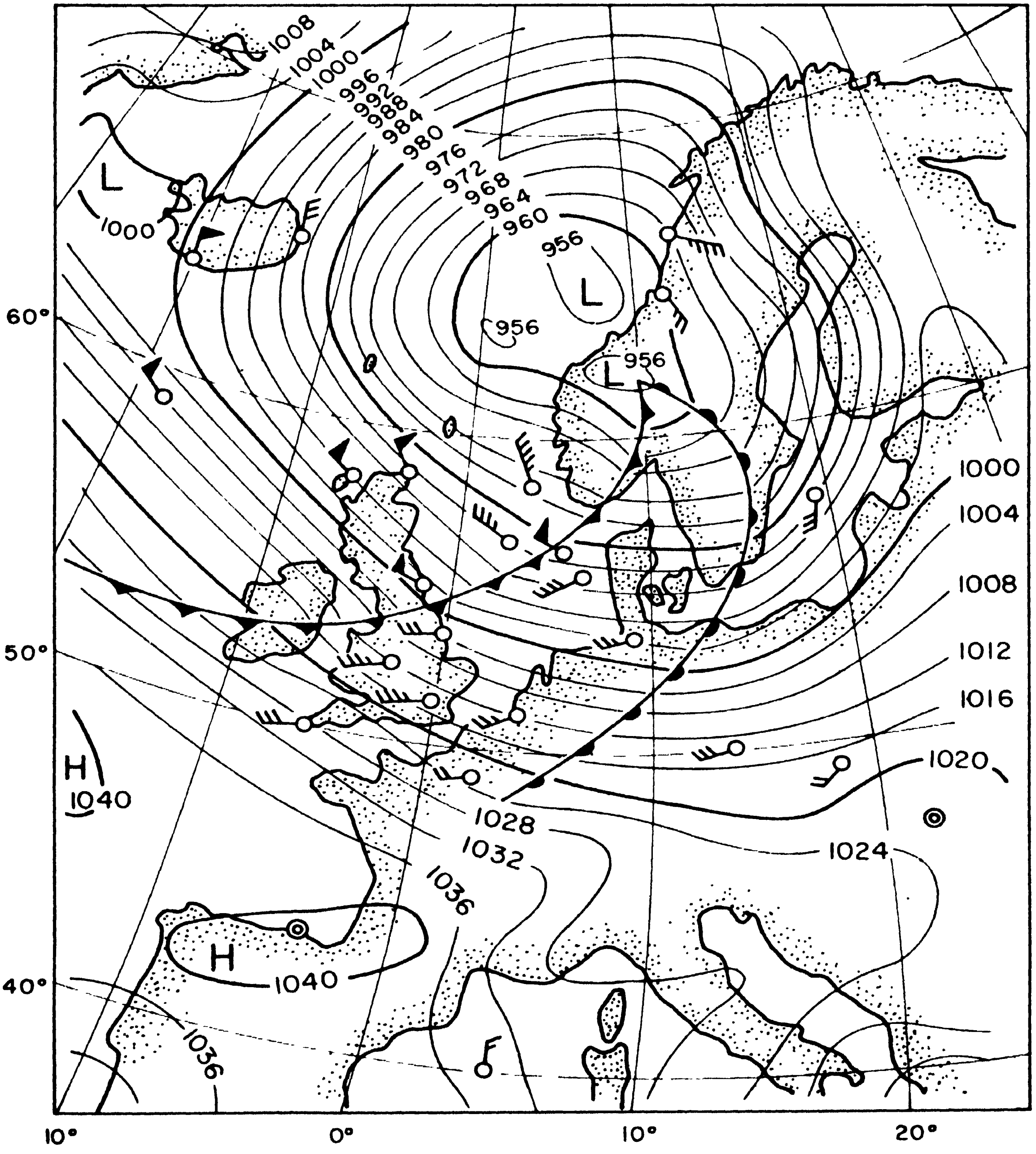


Fig. 21 0600 GMT 16 February 1962
F.E. Lumb:
'Meteorology of the North sea'
(American Geographical Society)

Flag represents 50 knots
Whole barb represents 10 knots
Half barb represents 5 knots
Calm
Arrows fly with the wind

3 HOW A WEATHER BULLETIN IS PRODUCED

3.1 Weather map

In order that we may have a clear picture of the weather it is necessary to construct a weather map, by using the data collected from various observation points all over the globe. Weather maps are constructed four times a day on the basis of observations made at 00:00, 06:00, 12:00, 18:00 hours Greenwich Mean Time, which are known as "standard observational hours". These times have been set by international regulation, although the maps are produced in accordance with national regulations for the use of various countries.

Meteorological observers at weather stations observe various weather elements, such as atmospheric pressure, temperature, humidity, cloud type and amount, wind, visibility and present weather conditions. These elements are coded by an internationally determined method and sent to the central weather bureau of respective countries only several minutes after the hour of observation, 00:00 GMT, etc. The weather man then plots these data on the map and draws isobars for the analysis. This takes about one to three hours, depending on the size of the region to be analysed. The analysed results and some data are sent to regional meteorological centres by wireless or teletype, Recently some countries have been using electronic computers and automatic map-drawing devices.

At the official weather stations it is compulsory for regular observations and reports to be sent in code to the central weather station of each country, but reports from vessels are generally voluntary. So, in order to have good and reliable data from ships, the ships' officers should be taught and guided by weather men at the main ports to assist them with their observations and reports. This system has been recommended by WMO, as the Port Meteorological Officer System, and most countries endeavor to promote it. (A manual on Port Meteorological Officer Activities will shortly be published in WMO's four official languages).

Meteorologists first plot the observation point and data observed on the map and then, with reference to the preceding series of weather maps, the isobars are marked in. We can now see whether the high pressure area has moved, whether the intensity of the centre of low pressure has increased and so on. Wind force is also marked, but accurate pressure reading is most important when drawing the isobar. Even a small difference in pressure between two points may affect the weather forecast considerably.

Reports of air pressure from ships are often critical with regard to the analysis of isobars over oceanic areas and the detection of sudden developments of weather over the ocean. Many times a ship report stands largely on its own, because of the comparatively great distance between two ships giving a weather report. For this reason it is of the greatest importance that the air pressure is correctly read on board ship and that no errors are introduced when the figures of the observed pressure and of the ship's position are transmitted to shore.

Officers of merchant vessels and skippers of fishing boats should be encouraged, therefore, to equip their craft with a good barometer and to make corrections at every port, on consultation with the official weather service of the port.

Meteorologists use not only surface weather maps, but also weather maps of various altitudes due to the observed data by radio sounding. They also currently construct a large number of supplemental maps and graphs for weather analysis.

3.2 Forecasting

Forecasts are usually issued 12 or 24 hours in advance, after detailed analysis of the weather map. Meteorologists start by forecasting the movement and general pattern of the high and low pressure areas. For example we know from experience that centres of high and low pressure, ridges and troughs move eastward in the middle latitudes. Sometimes the high pressure area remains stationary and sometimes a depression deepens rapidly; such features may be anticipated, according to whether it is a 12 or 24 hour forecast. Every day life on the mainland is directly or indirectly related to various weather conditions, such as strong wind, rain, temperature and visibility. Each Governmental meteorological service issues regular national weather forecasts for the general public as well as separate forecasts to cover coastal areas and the high seas.

Weather forecasts for sea areas are intended for the use of merchant seamen and fishermen, so the content of these forecasts is, naturally, different from those for inland areas. Such points, however, have not always been considered seriously.

This is because forecasters are not fully aware of the features of ocean-going conditions, especially of fisheries. The meteorologists may broadcast a forecast, only announcing the variations of weather for 24 hours in advance, stating, for example, that a severe depression of 940 mb will move eastward, and the storm area may cover 500 km from the center. As a result of misforecasting we often hear of fishermen cancelling fishing operations, and by so doing, missing an opportunity for successful fishing. Thus severe financial loss may be suffered by the fishermen. This, however, may be inevitable from the meteorological point of view, since though weathermen would like to make forecasts for all areas this is not possible where only scanty data are available, especially for extended, accurate forecasts. The solution would seem to be to promote research on forecasts over oceanic areas by meteorologists, and to frequently provide them with reliable weather data from fishing boats operating over the ocean. It is therefore imperative for fishermen and forecasters to make combined efforts in order to produce reliable weather forecasts which would provide the necessary information to benefit fishing operations.

As has already been stated, it takes some hours to disseminate the result of weather analysis as forecast after the "map time". The time schedule of such broadcasts is determined beforehand but there is some time-lag between the actual map time and the broadcast time. During this interval the weather is changing. Therefore, the fishermen must take this into consideration when interpreting the result of forecasts. However, it is up to the fishermen themselves to interpret and use such weather forecasts.

It should be borne in mind by fishermen that forecast areas are generally large and that the validity of forecasts usually extends up to 12 hours. Weather conditions frequently change considerably both in space and in time and the values given in the forecast represent average conditions for the area and period concerned.

Wave information is of vital importance to fishermen. The forecasting of wind and waves is closely related. Surface waves are caused by prolonged wind, and so forecasters may consider the features of the wind, i.e. its strength, direction and duration, in relation to the strength of waves. In forecasting waves it is necessary to anticipate the weather situation 24 hours in advance, and to know the strength of the expected wind. To achieve this, meteorologists estimate the future distribution of pressure on what is known as a prognostic chart. This chart is sometimes composed with the aid of an electronic computer and just gives a general outline of the strength of the waves, which would be useful to fishermen at sea.

Wave forecasts are now being made currently in several countries, and it is hoped they will be used in all countries for the benefit of fishermen. There are many elements of which the fishermen should be informed, such as fog, ice, bad visibility, etc. The forecasters of maritime countries should bear in mind that weather phenomena are of special importance to fishing boats, which are not as large as merchant vessels and apt to be threatened by severe weather, and their livelihood affected by much less than severe weather.

4 HOW TO MAKE USE OF WEATHER INFORMATION

4.1 Weather information by newspaper, radio and television

Almost all newspapers give weather information in their respective national language, but the content may differ according to the paper; some include very precise maps and sometimes prognostic maps, and others even publish sea surface temperature maps.

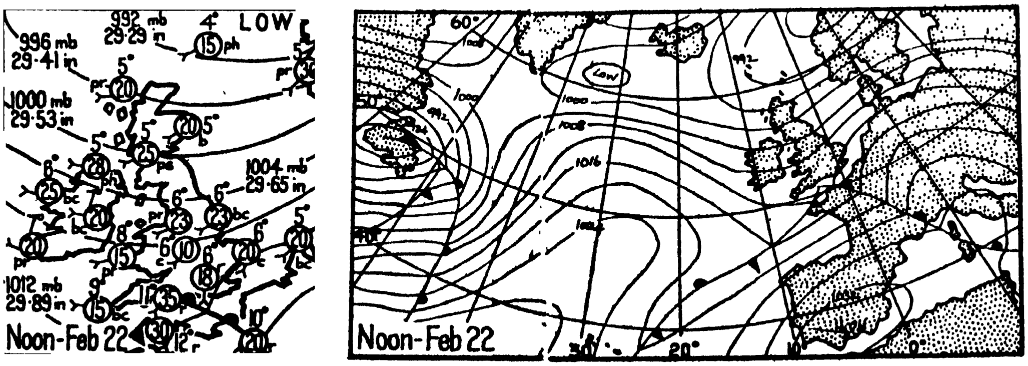


Fig. 22 Weather map in the newspaper. 22 February 1967

(Courtesy of Guardian)

Similar information may be obtained from ordinary radio and television services, and in some countries there is a special telephone service for weather forecasts, that is, you can listen to a recorded weather forecast by calling a special telephone number.

This information is available to everyone, but it is not at all specialized. More detailed weather bulletins, including up-to-date weather maps issued by meteorological services, giving more precise data, can be obtained by anyone from the weather bureau in most developed countries.

These bulletins are most helpful when planning operations, and fishermen are recommended to contact the weather officers as frequently as possible to find out the general trend of weather in the scheduled fishing grounds at the scheduled period. All weather stations keep or have access to records of past weather and relevant information which may be put at the disposal of fishermen.

A contact should exist between fishermen and weathermen at the fishing ports, and WMO is now asking member countries to promote this kind of contact.

4.2 How the weather information is relayed to fishing vessels

Fishing vessels at sea may often encounter bad weather which can prevent operations and threaten their safety. In such an event, skippers would only be able to take preventative measures if they were forewarned of the change in weather.

As long as ships do not operate too far from shore they may be able to receive weather information through normal radio channels and by visual storm warning signals, displayed on the shore. But if they are very far out to sea it becomes necessary to receive weather information through wireless transmitting stations, having tuned in to the appropriate frequency of the nearest transmitting station. Such information is generally sent out in Morse Code at a predetermined time and occasionally by Radio Telephone in plain language and at dictation speed.

There are more than 150 transmitting stations in the world, as shown in Fig. 23. Precise information on transmission schedules is to be found in WMO Publication N°.9 (Vol.D), but it is too inconvenient to carry this publication on the average size fishing boat. However, weather stations on shore should have a copy of this and fishermen can contact these stations to get the necessary information for the area in which they are.

For example, should a fishing boat wish to operate in the Atlantic west of France and Spain, it will be found, on consultation with the above mentioned WMO Publication, that this fishing ground is covered by transmitting stations in France, Spain and the United Kingdom.

Several weather bulletins are broadcast each day, but if the operator should miss receiving one message he would have to wait rather a long time for the next transmission. Some messages may be very short and simple in content, but others are much more detailed and cover an extensive area, enabling the ship's officer to draw up a fairly accurate weather map. As can be seen from the following tables, messages are often sent out in the language of the country transmitting and those fishermen not familiar with foreign languages will find it difficult to interpret the message. But the technical terms used are easily understood if fishermen have some background knowledge of meteorology (see Appendix I a list of technical words in three languages).

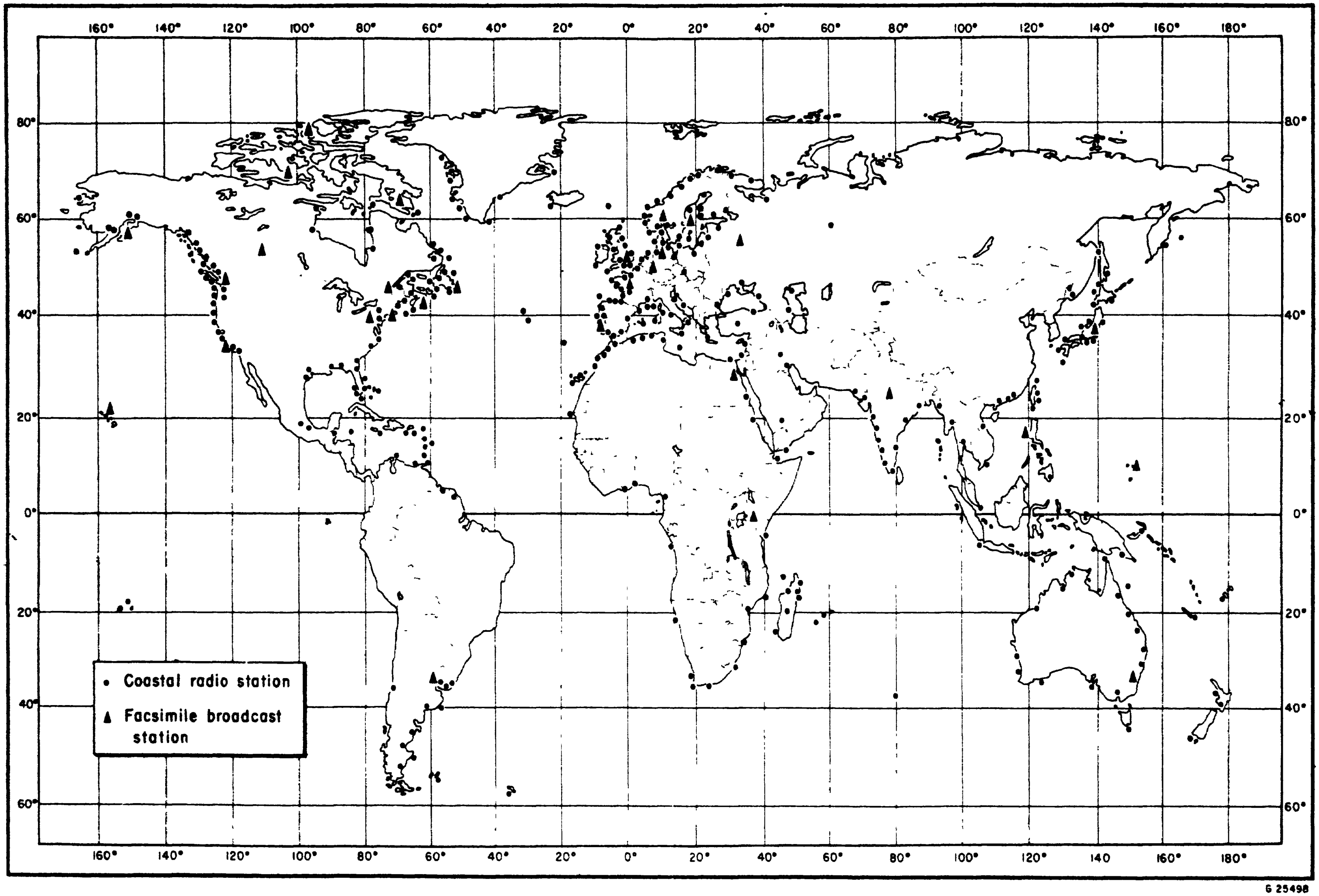


Fig.23 Coastal radio stations and facsimile stations transmitting weather informations

F R A N C E

Date: 1.1.1965

Group : B

Station: BORDEAUX
Area affected: Coastal area from the Loire estuary to the French-Spanish frontier

(a)	(b)	(c)	(d)	(e)
-	(0530, 0630) (1130, 1830)	1 205 kc/s	A_3	100 kW

1	2	3	4	5
0530) 0630)	0000) 0300)	Forecast	In clear (French)	Information for coastal fishing and shipping for the area affected
1130	0600) 0900)	Forecast	In clear (French)	See 0530
1830	1200) 1500)	Forecast	In clear (French)	See 0530

Notes: (a) The morning bulletin contains: weather observed on coast at 0300 GMT (or, failing that, at 0000 GMT); a summary of the general situation at 0000 GMT and of its evolution; a forecast valid for the day and the general nature of the weather for the following night, and also if necessary, notification of wind or storm.

(b) The midday bulletin contains: weather observed on coast at 0900 GMT; a summary of the general situation at 0600 GMT and its evolution; a forecast valid for the afternoon and night, and, if necessary, notification of wind or storm.

(c) The evening bulletin contains: weather observed on coast at 1500 GMT; a summary of the general situation at 1200 GMT and of its evolution; a forecast for the night and the general nature of the weather for the following day, and also, if necessary notification of wind or storm.

Each of these bulletins covers the coastal area (20 nautical miles)

FRANCE

Group : B

Date: 7.1.1965

Station: BORDEAUX/ARCACHON RADIO
Area affected: South-western coastal waters of France, Bay of Biscay

(a)	(b)	(c)	(d)	(e)
FFC	(0715, 1645	1 820 kc/s	A_3	1 kW
	(On receipt,) (H+18, H+48,) (0948, 2148)	421 kc/s	A_2	1 kW
	(On receipt,) (H+03, H+33,) (0948, 2148)	1 862 kc/s	A_3	1 kW

1	2	3	4	5
0715			In clear (French)	Gale/storm warnings, or, as necessary, the phrase "Avis de tempete : Neant"
	0000) 0300)	Situation) Development)	In clear (French)	General situation Development
	0000) 0300)	Forecast	In clear (French)	Forecasts valid for 12 hours Probabilities for the following 12 hours Further weather outlook for the areas: (a) Sud Gascogne (b) Cap Finisterre
	0600)	-	In clear (French)	Observations from La Coubre, cap Ferrat and Chassiron signal-stations
1645	1200) 1500) 1200) 1500)	Situation) Development)) Forecast)	In clear (French)	See 0715
	1500	-	In clear (French)	See 0715

UNITED KINGDOM

Date: 11.10.1965

Group : C

Station: WHITEHALL (London)
Area Affected: Atlantic ocean north of 35°N, east of 50°W and the North Sea

(a)	(b)	(c)	(d)	(e)
GYC	0000-2400	78.2 kc/s	A_1	
GYC 2	1645-0800	4 301 kc/s	A_1	
GYC 3	0000-2400	6 414.5 kc/s	A_1	
GYC 4	0000-2400	8 614 kc/s	A_1	
GYC 5	0000-2400	12 808.5 kc/s	A_1	
GYC 6	0000-2400	17 031.2 kc/s	A_1	
GYC 7	0800-1645	22 455 kc/s	A_1	

1	2	3	4	5
0446	0000	IAC FLEET	FM 46.C	Surface analysis
0600		Forecast	In clear (English)	Forecasts for waters surrounding British Isles, valid for 12 hours from time of broadcast, with 12-hour outlook for the areas 1): Hebrides, Fair Isle, Cromarty, Forth, Tyne, Humber, Thames, Dover, Wight, Portland, Plymouth, Finisterre, Sole, Fastnet, Lundy, Irish Sea, Malin, Shannon
1646	1200	IAC FLEET	FM 46.C	Surface analysis
1800		Forecast	In clear (English)	See 0600
When necessary			In clear (English)	Gale warnings for the areas 2): Iceland, Faeroes, Baily, Hebrides, Fair Isle, Viking, Cromarty, Forties, Fisher, Forth, Tyne, Dogger, German Bight, Humber, Thames, Dover, Wight, Portland, Plymouth, Biscay, Finisterre, Sole, Fastnet, Lundy, Irish Sea, Malin, Shannon, Rockall

SPAIN

Group : D

Date: 27.1.1965

Station: MADRID (Ciudad Lineal)
Area affected: Eastern Atlantic and Western Mediterranean

(a)	(b)	(c)	(d)	(e)
EBA	0900, 1730	6 408.5 kc/s	A_1	1 kW

1	2	3	4	5
0900	0600	Situation Forecast	In clear (Spanish)	Re-transmission of the complete bulletin broadcast by Madrid (Retiro) at 0830
1730	1200	Situation Forecast	In clear (Spanish)	Re-transmission of the complete bulletin broadcast by Madrid (Retiro) at 1700
	1200	IAC FLEET	FM 46.C	

The following abbreviations have been used in the tables:

(a) call sign
(b) broadcast times
(c) frequencies
(d) type of modulation
(e) power of station

1. time of transmission
2. time of observation
3. type of message
4. code forms or language used
5. contents and remarks

A : Amplitude modulation
A_1: Telegraphy without the use of a modulating auto frequency (by on-off keying)
A_2: Telegraphy by the on-off keying of an amplitude - modulating audio frequency or audio-frequencies, or by on-off keying of the modulated emission (special case: an unkeyed emission amplitude modulated)
A_3: Telephony

FRANCE

COASTAL FORECAST AREAS

1 January 1965

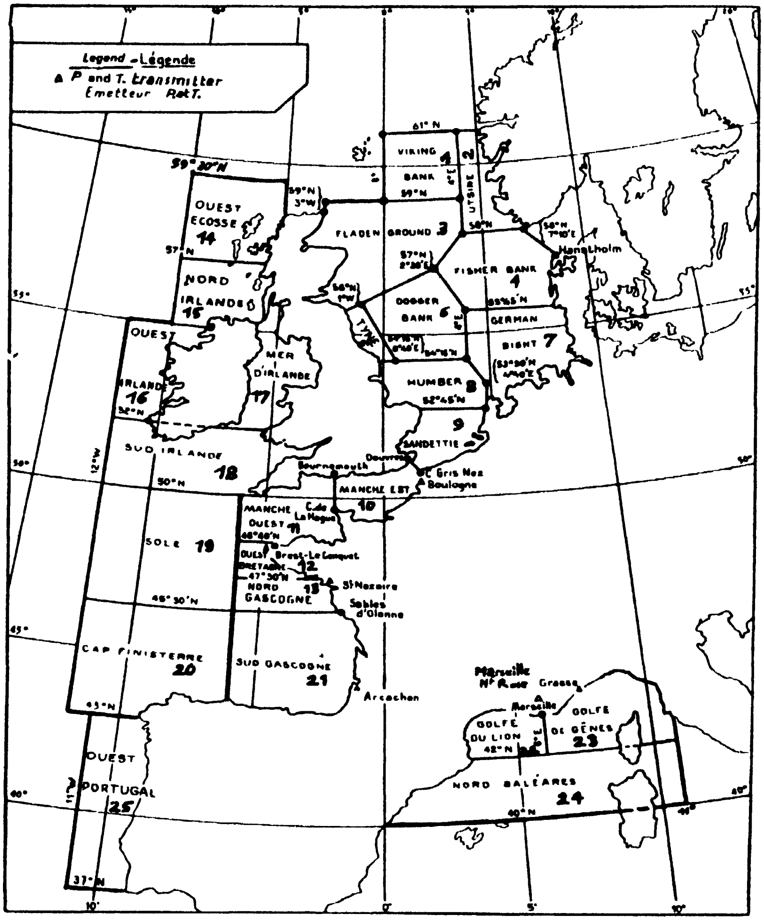


Fig. 24 Coastal weather forecast. Area of France

UNITED KINGDOM

WEATHER FORECAST AREAS

29 July 1965

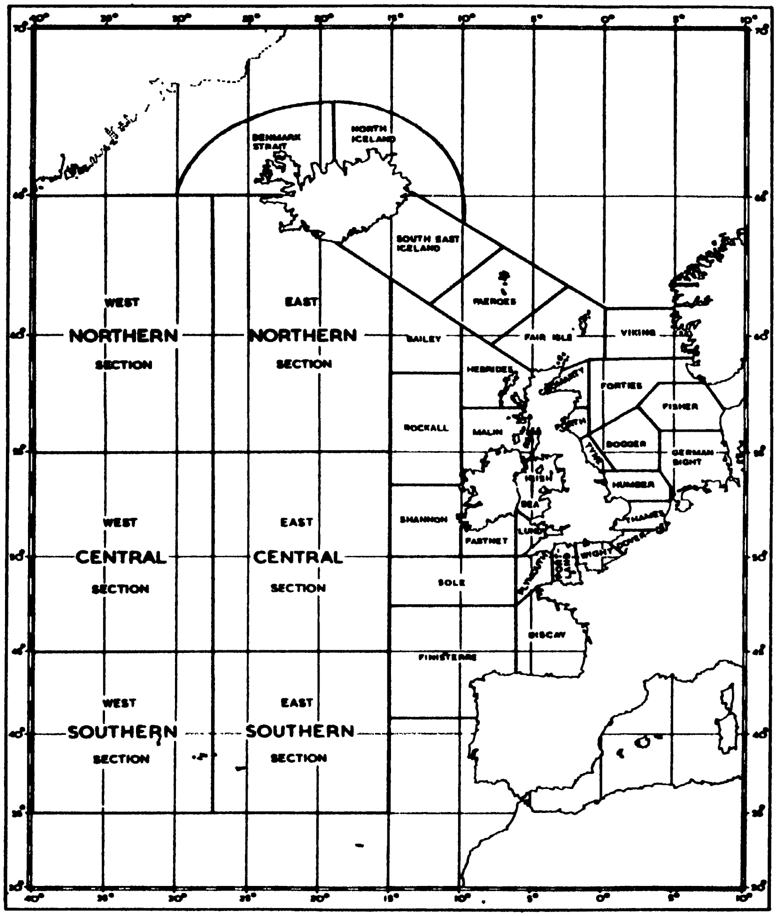


Fig.25-1 Weather forecast area (United Kingdom)

UNITED KINGDOM

WEATHER FORECAST AREAS

29 July, 1965

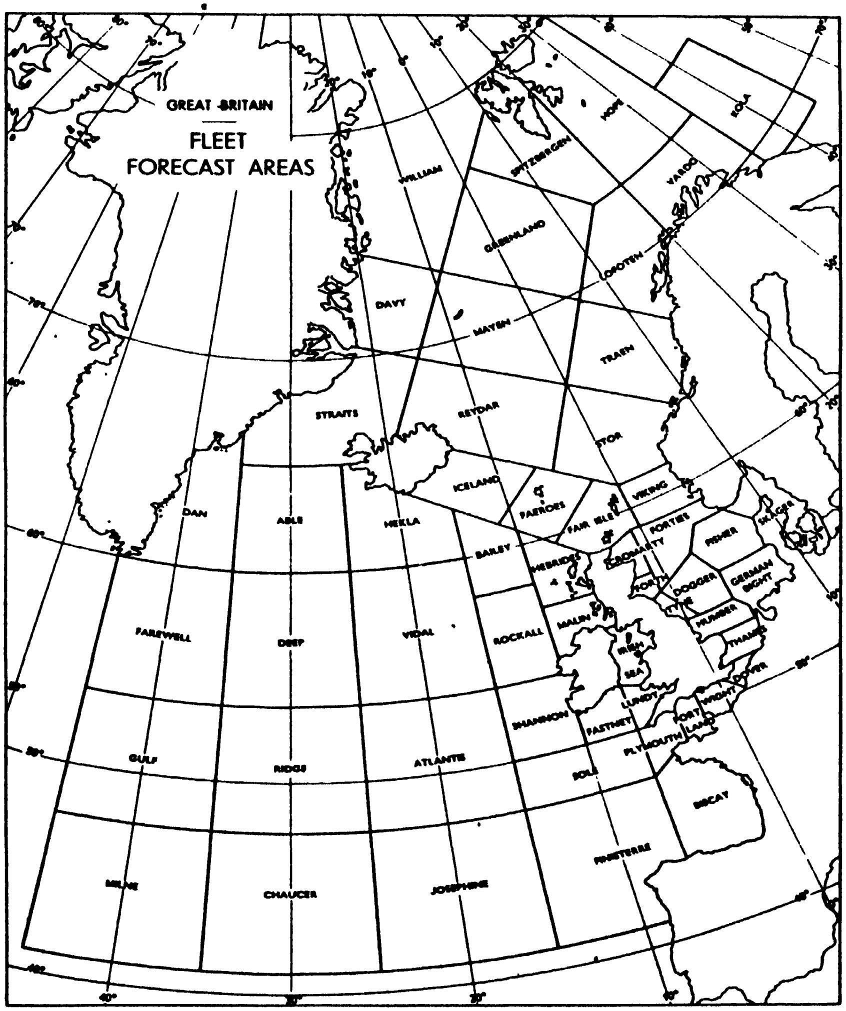


Fig. 25-2 Weather forecast area (United Kingdom)

SPAIN

WEATHER FORECAST AREAS

27 January, 1965

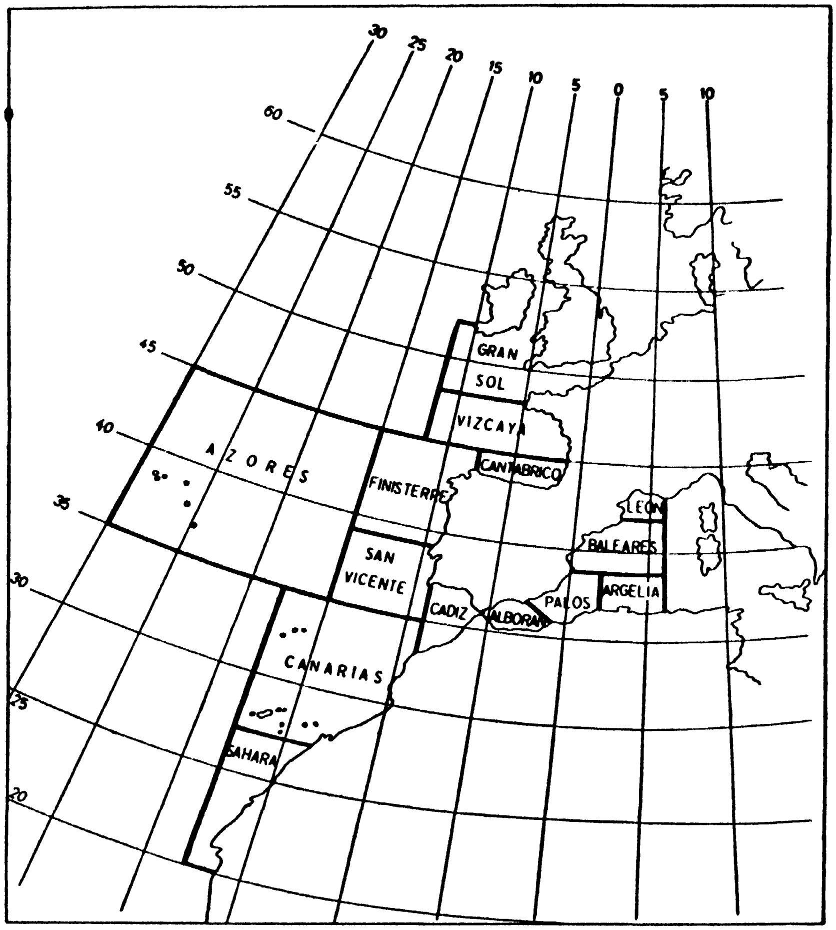


Fig. 26 Weather forecast area (Spain)

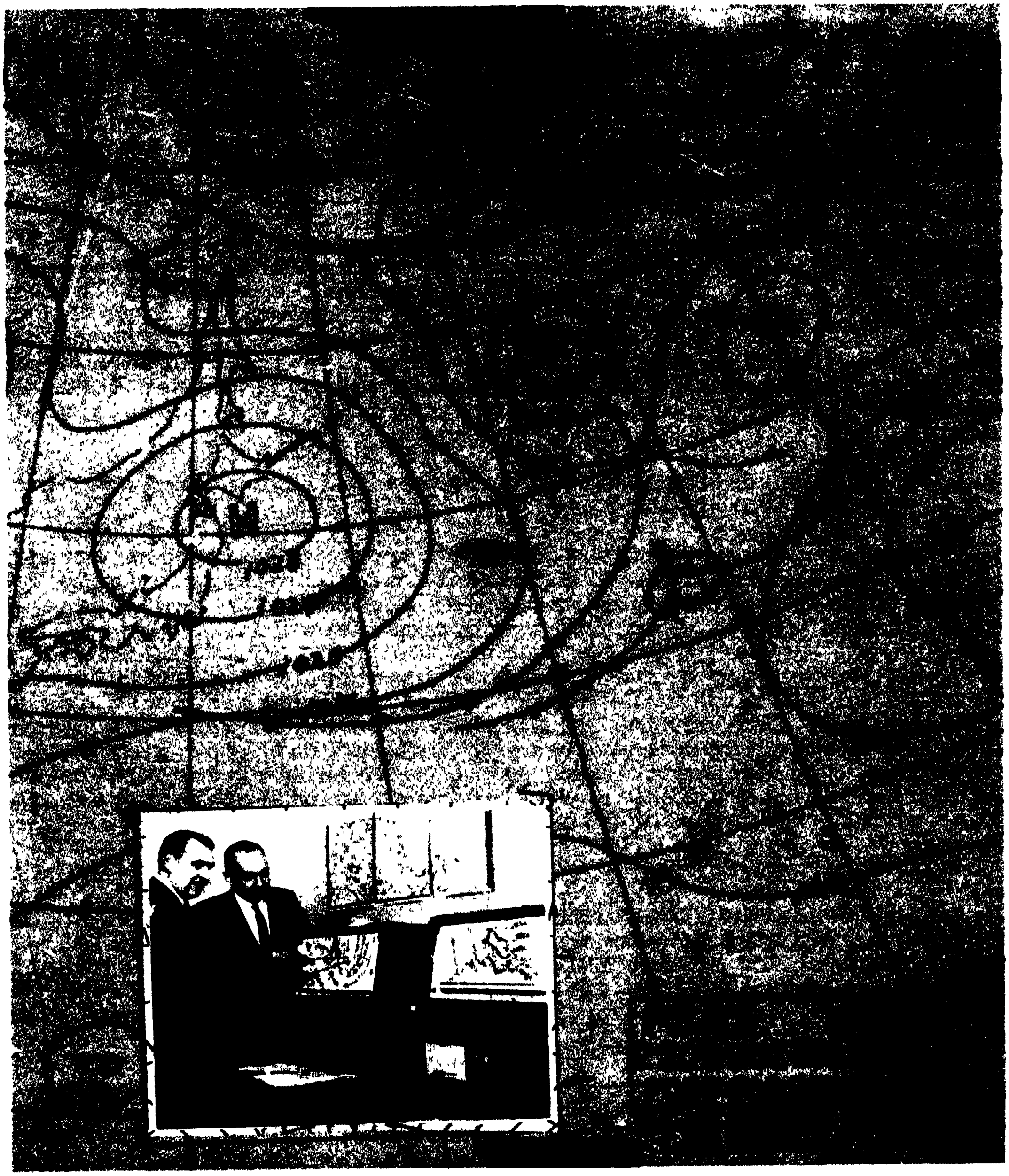


Fig. 27 Reproduction of weather map by a facsimile

Nowadays there is a new system known as facsimile transmission. A facsimile transmission table is also shown in WMO Publication 9 (Vol.D). At present there are about 20 transmitting stations in the world. Weather maps can be reproduced automatically in less than 20 minutes by the receiving set, giving very useful information on fishing conditions in any area, sea surface temperature distribution, etc., and it is therefore strongly recommended that vessels, especially if operating for long periods over the ocean, have receiving sets installed. In some countries fishermen are already making good use of this service. For example, in Japan there are more than 300 fishing boats equipped with facsimile receiving sets.

Recently a small and extremely handy facsimile receiving set was introduced. Fig. 27 is a reproduction of a weather chart (map size 17 x 20 cm) received by such a receiving set. On this chart even small letters are clearly shown. An illustration of the set is shown.

There are very few transmitting stations in the southern hemisphere. Therefore in that area the weather information and weather forecasts are sometimes not very good, and fishermen operating there complain of this frequently.

4.3 How to interpret weather information in conjunction with fishing operations

Weather forecasts sometimes do not correspond with the actual weather as we know from experience. The present rate of accuracy is 70 to 80 per cent but there is much smaller margin of accuracy for long-range forecasts. Fishermen should always take this into consideration.

The weathermen may issue a 12-hour warning of a particular depression which is due to hit a certain oceanic area. Fishermen operating in that area will receive the warning by wireless and organize their operations accordingly. Those fishermen already finished with operatinns, with the catch on deck, may decide to take shelter in harbor, and others beginning all-night fishing operations may decide to put off operations. Such decisions should be taken by the fishermen themselves.

4.3.1 Avoiding storms

Weather forecasts give information such as the position of low and high pressure areas and their movement. As is shown in Fig. 28 a depression of 970 mb is moving ENE at a speed of 25 km/hour. The fishing ground (A) is located in its path at a distance of 600 km from the depression center which will be encountered the following day (600/25 = 24 hours). The position of the depression will have been forecast and the storm area given as 150 km radius. Thus the edge of the storm area (B) may be encountered by the fishing vessel within the next eighteen hours $\frac{(600 - 150)}{25} = 18$ after the warning. If the ship were to remain stationary the relative distance between ship and depression would rapidly decrease. So, after 18 hours point (B) of the depression will encounter the ship which experiences a southerly wind of say 12 m/s. To avoid the storm will necessitate sailing far beyond the isobar 990 mb where the wind will be less than 4 m/s, and after 18 hours the ship should be in the region of (C) in relation to the depression. To achieve this the ship must sail SE from (B) to (C), or further. If the distance BC is 180 km, the fishing vessel must travel at a speed of 180/18=10 km/hr (or about 5 knots). The maximum speed of the fishing vessel is assumed to be 10 knots. The vessel will then be able to avoid the storm.

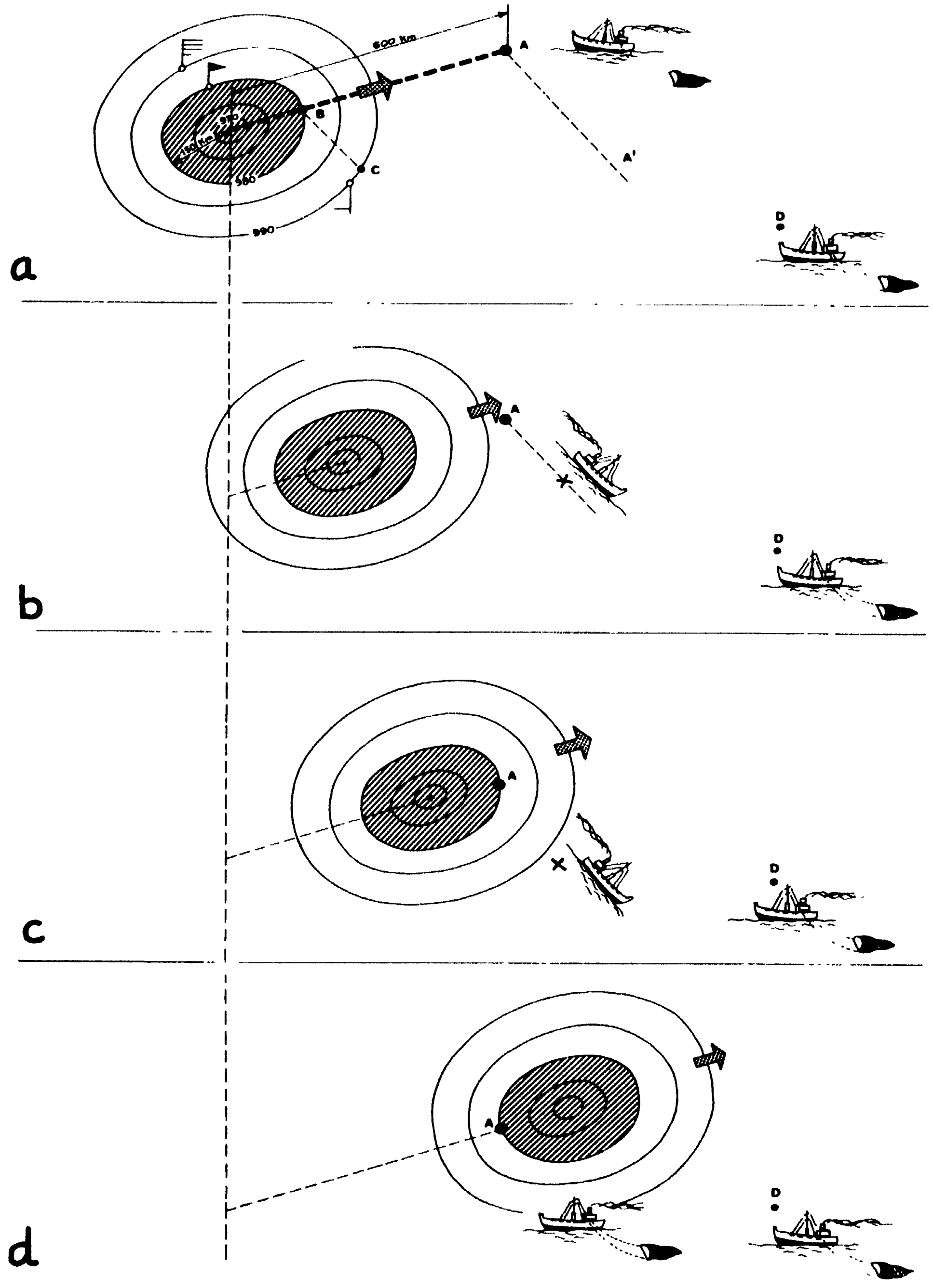


Fig. 28 How to avoid the storm

The above description has been made relative to the depression, but in reality the fishing vessel must sail in a SE direction, as shown by the dotted line (A-A'). The feature of the relative relation with the depression may be clarified in Fig. 28 a - d.

The speed of the fishing vessel becomes very slow when it encounters high waves (Fig. 29). Moreover, fishermen should take into account the fact that there will be a margin of error in the forecasting of speed and direction of the depression, and so to avoid the storm they should move to a safer area with maximum speed.

The fishing boat at (D) may be safely off the path of the depression but the depression may change its direction abruptly or its strength may increase unexpectedly, and so the fishermen at (D) should try and gain more information and operate with special care.

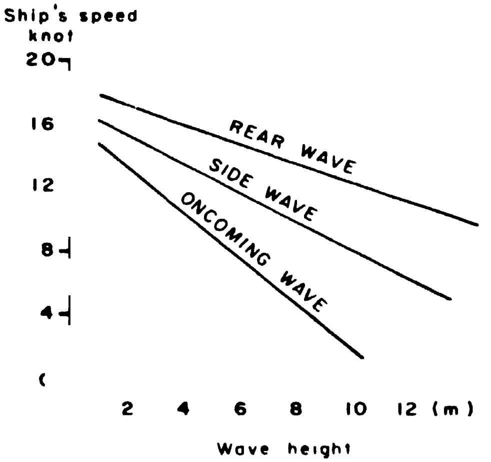


Fig. 29 Relationship between wave height and ship's speed

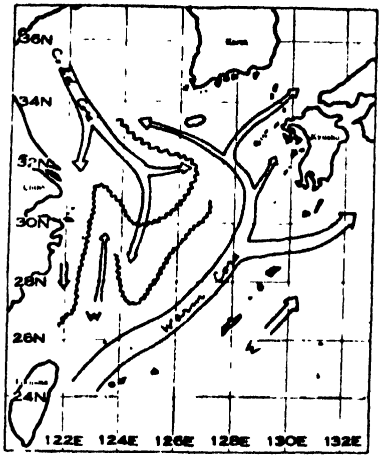
4.3.2 How to utilize the sea surface temperature for fishing operations.

When determining the position of fishing grounds it is preferable to have some knowledge of the distribution of sea surface temperatures. It is especially important to have a knowledge of the oceanic area of high temperature gradient, since we can often find good fishing grounds in these waters.

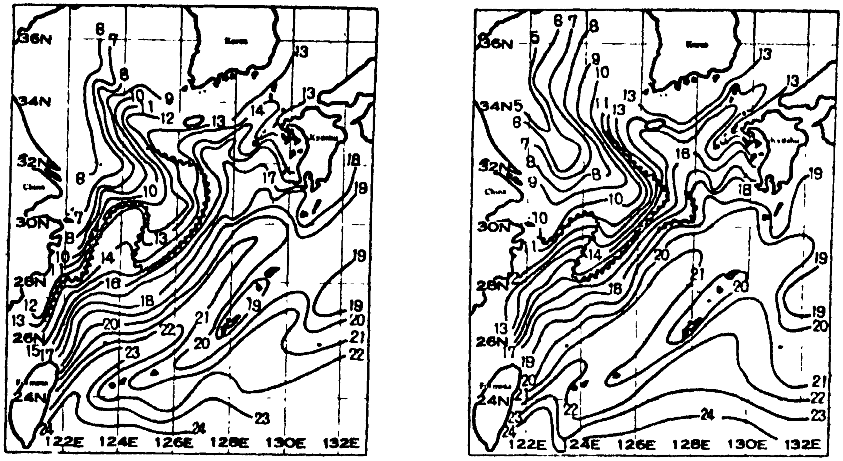
Owing to lack of data it is difficult to produce a daily isothermal map which would cover the whole ocean. But fortunately the sea temperature is of a conservative nature. Isothermal lines can thus be based on less frequent readings and the resulting information will be more or less useful. Some countries issue isothermal maps based on data obtained from routine weather reports from merchant ships, research vessels and fishing vessels every five or ten days. The average temperature will change a little with time and even a light change, especially on the boundary area of warm and cold currents, may bring about a change in fishing conditions.

The East China Sea is located on the continental shelf and there we find good fishing grounds. In order to aid fishing operations effectively in that area, Japanese fishermen have learned how to use the data they collect on surface temperature, by reporting to the meteorological station at the port of Nagasaki; the Nagasaki Marine Observatory can then use this data and that collected by the merchant ships in the same region for the regular issue of the sea surface temperature map.

The attached maps show reports of sea surface temperature for the period 11-20 and 21-28 February, 1957, and the general feature of the distribution of water mass in the East China Sea. Wave-like isotherms indicate the boundary of the warm Kuroshio current and the cold water of Yellow Sea origin. Different species of fish may be caught in the warm and cold areas near this boundary. In comparing these two maps we can perceive the change of feature in the boundary within a period of two weeks. Fishermen are always very eager to obtain information from the weather stations on the estimated position of the boundary which in turn will lead to successful fishing operations. (Fig. 30)



Distribution of water mass in the Eeastern China Sea,



The 2nd ten-day of February 1957.

The 3rd ten-day of February 1957.

Fig. 30 General features of water mass and surface temperature of the East China Sea

Some countries also issue information about sea temperatures at levels below the surface.

Dense fog is frequently encountered in those areas connected with the boundary layer of warm and cold currents. Fog forms with a warm wind blowing over the cold surface, and the denser the fog (i.e. the worse the visibility), the greater is the difference in temperature of air and sea . This will have a bearing on fishing operations. For example, whaling ships select areas of good visibility for catching whales, and so the meteorologists working with the whaling fleet make special forecasts for their own use, with special regard to the occurrence of fog.

When the water temperature drops below zero, at the end of autumn and during the winter, the water in the polar regions freezes and the frozen area will increase according to the season. This may bring about bad conditions for fishing operations. As the climate becomes warmer floating ice or icebergs appear in the middle latitudes, resulting, when the ice melts, in good fishing grounds since the floating ice may also bring nutrient substances in it.

In winter, when the air temperature drops below -5°C and the wind force is stronger than 10 m/s, fishing boats may become covered with ice. Statistical research which has been carried out on ice accretion in the northern hemisphere will help ships keep clear of dangerous areas (Fig. 31)

The important point is not to head into the wind. Less icing occurs when running before it, but to do this the ship must be turned before it is seriously iced-up.

Fishing boats operating in the polar region sometimes experience very heavy ice accretion. This is known as black ice among fishermen and is considered very dangerous for fishing boats. Although a similar problem of ice accretion has been studied frequently on airplanes,when they pass through clouds of supercooled water droplets, no meteorological explanation has yet been given regarding black ice on fishing boats. However, black ice is closely related to the existence of supercooled water droplets just over the ocean.

We know that a water droplet usually becomes an ice particle when the temperature of the droplet falls beneath 0°C, but there are occasions when water droplets do not change to ice, even when the temperature is far below 0°C. Air in such a condition is called 'supercooled' and the black ice is closely related to this state of atmosphere. If a fishing boat sails under such conditions every part of the boat is soon covered by thick ice, and in these circumstances the fishermen must endeavor to turn and sail out of such an air mass.

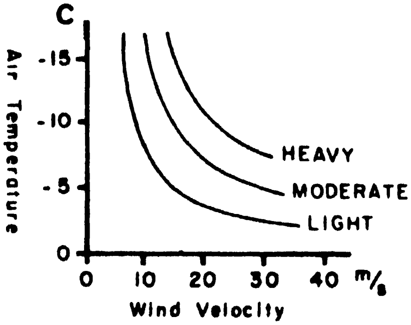


Fig. 31 Ice accretion

4.3.3 Some tips on forecasting weather without assistance

Fishermen know from experience whether the weather is suitable for fishing operations. Each operation will generally last some hours so fishermen must select a period of good weather which will last throughout the operation.

Consultation with meteorological offices to obtain up-to-date information is highly recommended for good fishing results. On the fishing grounds fishermen may forecast imminent weather conditions with the aid of weather bulletins. In this connection the following points should be noted:

(i) Fishermen are wise to watch for changes in air pressure in case a depression is approaching. If possible it is recommended that data be recorded continuously for some time. It is most important to find the tendency of pressure and fishermen should organize their operations, taking into consideration the coming depression;

(ii) In colder areas fishermen should watch for warm air currents which are frequently the cause of dense fog. The fog is likely to continue for a long time over a very large area, so hindering effective operations.

(iii) If strong wind continues to blow for several hours and is expected to go on for some time, rough seas will minimize the efficiency of operations. It is difficult for the fishermen to forecast waves and there are only a few weather stations which issue special wave forecasts.

5 METEOROLOGICAL OBSERVATIONS AT SEA

5.1 Instruments

When collecting oceanic data it is first necessary to determine the ship's position, and this is the responsibility of the ship's captain or skipper. This would appear a simple matter but in the great ocean expanses it is not always so easy.

The ship's position is generally determined by solar and astronomic observation with the aid of the sextant and chronometer. But during rainy, stormy or foggy weather, it is often impossible to determine the position because the sun and stars are not visible. The error of position is sometimes 5 miles or so but can be larger in the ocean.

The Loran and Decca systems have recently been developed but there are many oceanic areas which cannot be reached by these systems. In the areas covered by these systems, the position of a ship can be plotted more or less accurately according to the distance from the transmitting station.

On board ship the meteorological instruments encounter quite different environmental conditions to those of the land stations. Namely:

a) constant vibration from the ships' engines;
b) constant rolling, pitching and yawing of the ship;
c) salty, humid air which causes rust in instruments;
d) constant wind effect due to the moving of vessel;
e) difficulty of installing tall pole for equipment.

So weather instruments on board ships should be able to withstand rough conditions, and very accurate, sensitive instruments can generally not be used, except on large ships.

5.2 Barometer

As has already been mentioned, atmospheric pressure measured on board plays an important part in weather analysis. Observation could be made with the accuracy of 1 mb.

Mercury barometers which work on the principle of Torricelli's experiment (see paragraph 2.3) have been used on board merchant ships for a very long time. These instruments are very accurate; reading the pressure on board ship is, however, not too easy because the top of the mercury column in the glass tube constantly moves up and down a bit according to the rolling and pitching movements of the ship, despite precautions taken to damp the so called "pumping" of the mercury column.

Now ships are beginning to use the Aneroid barometer (see Fig.32) which is hung on spirals and set on a rubber cushion to prevent vibration from engines, etc. This type of barometer can be read much easier on board ship. It is also a reliable instrument, if certain precautions are taken. The Aneroid barometer is liable to shift its zero setting suddenly as a result of vibrations or from other causes.

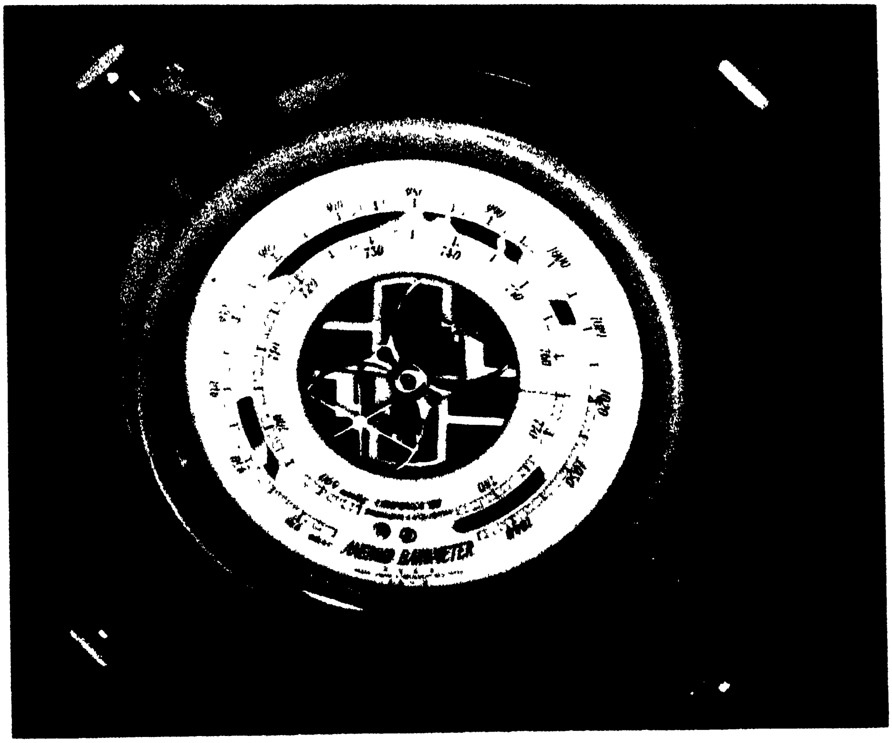


Fig. 32 Aneroid Barometer

The shift occurs unnoticed and it results in sometimes grave errors of the pressure readings. It is, therefore, strictly necessary to check the barometer regularly, at least once every three months. This can be done by comparing the pressure reading made on board when the ship is in harbour with the simultaneous reading of the standard barometer of the port meteorological officer.

Skippers on fishing boats carrying a barometer are strongly advised always to contact the port meteorological officer when harbouring in order to have the barometer checked.

5.3 Wind vane and anemometer

When measuring the wind on board ship one should take into account ship speed and direction.

If, for instance, there is no wind and the ship is moving westward at say 10 knots, the observer on board will feel the westerly wind at a wind speed of 10 knots. But if the ship is moving in a westerly wind of speed 5 knots, the westerly wind measured on board will be 15 knots. Thus, in order to find the correct wind speed, we must subtract the ship's speed from the recorded wind speed. Therefore, in the former case: 10 (observed) - 10 (ship's speed) = 0; and, in the latter case; 15 (observed) - 10 (ship's speed) = 5. (Fig. 33).

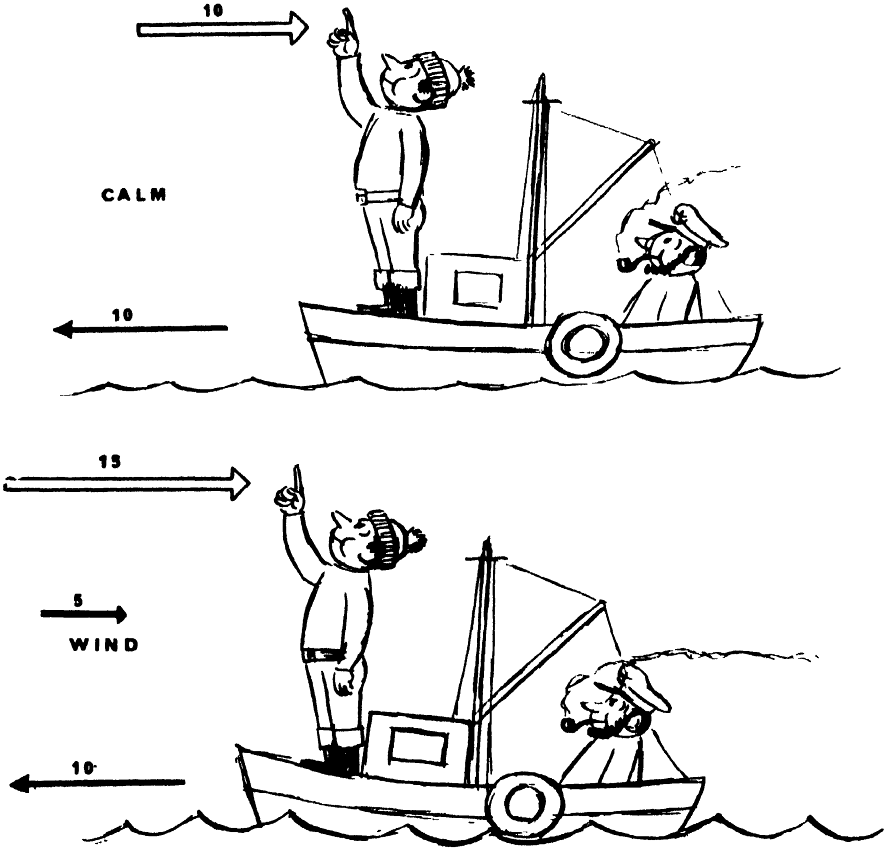


Fig.33 Apparent and actual wind velocities

The correct wind speed may be calculated from a graph showing the speed and direction of the ship and the recorded wind speed. In Fig. 34 a ship is shown moving westward at 10 knots and we draw an arrow 'AB' from the ship's position 'A'.

If the recorded wind is WNW 26 knots, we mark an arrow indicating the wind direction 'BC'. The wind velocity is then shown by an arrow connecting 'A' to 'C'. In this example the wind direction will be NW and wind speed 20 knots.

To obtain a correct wind recording the following steps (a) or (b) should be followed:

(a) Draw the ship's speed 'AB' and then draw a line 'BC' indicating the recorded speed. The correct wind speed is shown by 'AC'

(b) Draw line "A'B" first, indicating recorded speed of wind, and then ship's speed "B'C". The correct wind speed is shown by "A'C"(Fig.35).

Wind is usually recorded by an ordinary wind vane and an anemometer installed near the top of the mast, or at some other high position in order to eliminate as much turbulence as possible. But such an instrument is bound to be affected by rolling and pitching and so it is difficult and sometimes impossible to make correct measurements of the wind at sea.

The wind force and the wind direction can be estimated by observing the waves and other wind effects on the sea surface (foam, spray). The wind force is estimated according to the numbers of the Beaufort wind scale. The following table and the pictures of Fig. 36 provide an aid for the inexperienced observer. The table also gives the conversion from the Beaufort scale numbers which are estimated, to the wind speed in knots which should be reported. The wind direction can easily be estimated according to the alignment of the wave crests.

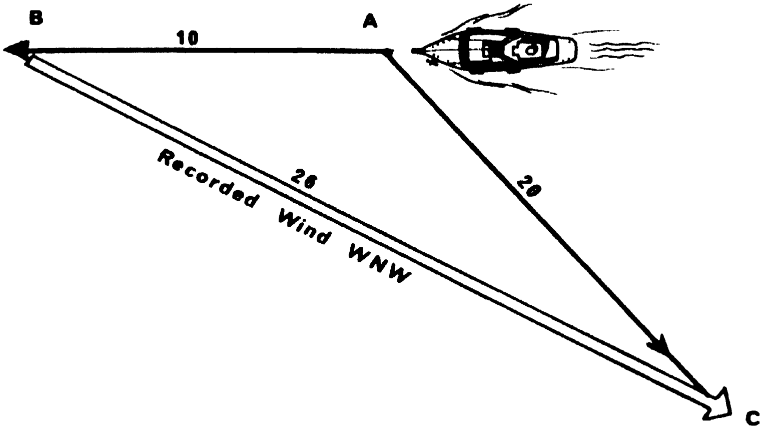


Fig. 34 Graphic method to obtain wind speed from a record on board.

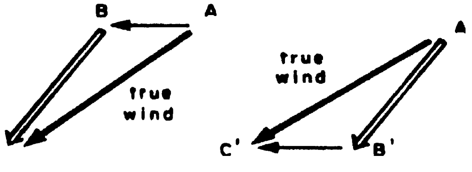
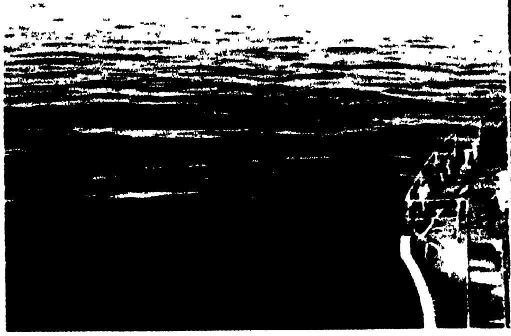
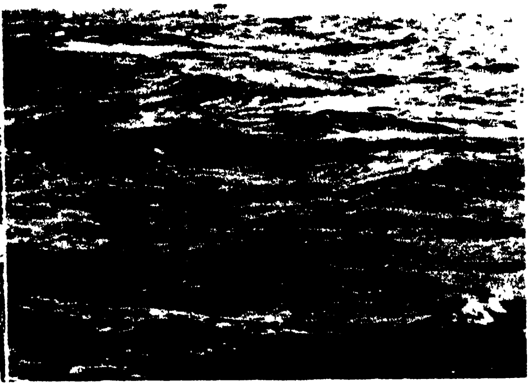


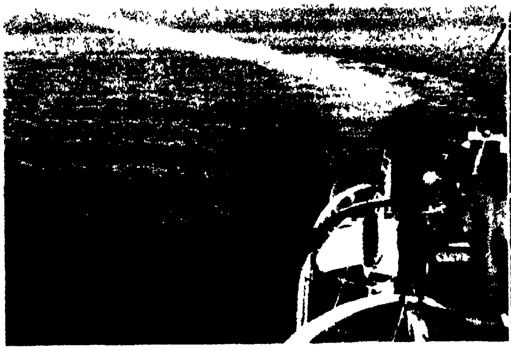
Fig. 35 Graphic method to obtain wind speed from observed record on board (cont'd)



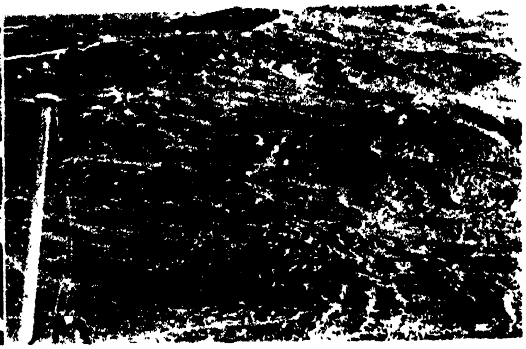
1 Light air



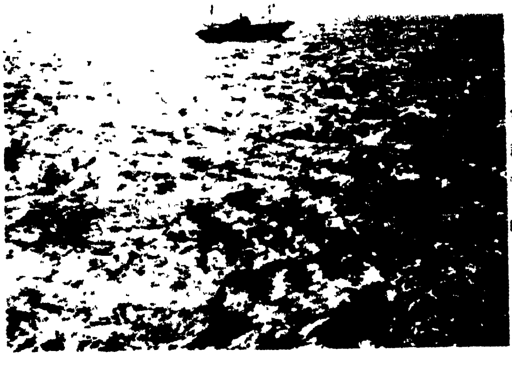
4 Moderate breeze



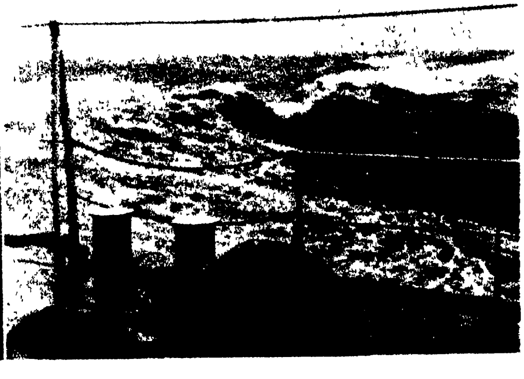
Light breeze



5 Fresh breeze

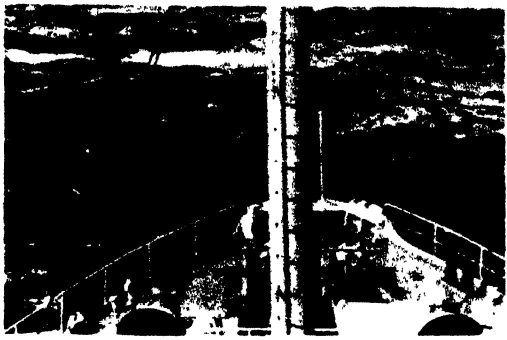


3 Gentle breeze



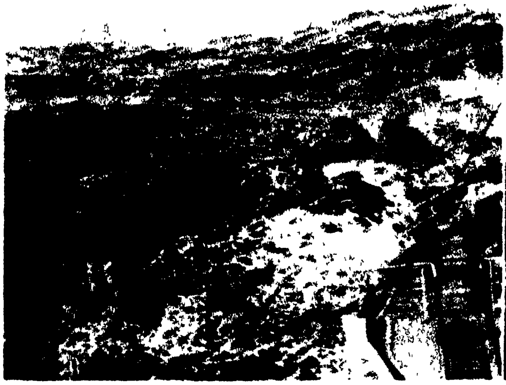
6 Strong breeze

Fig. 36 Beaufort Scale of Wind

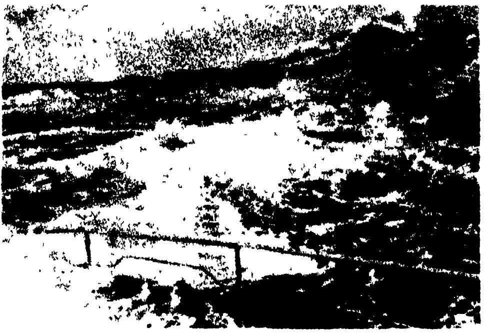


7 Near gale

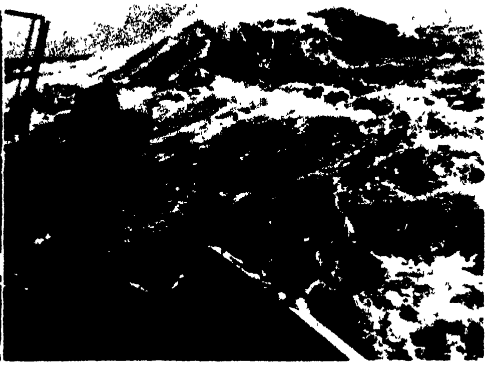
8 Gale



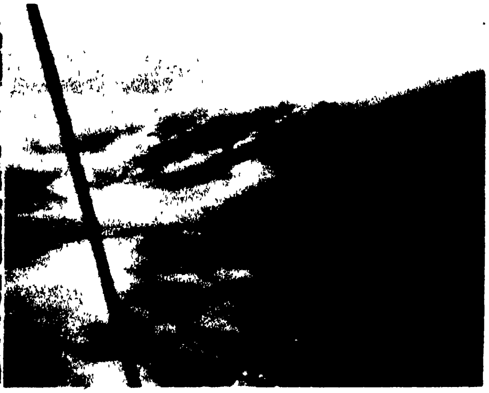
9 Strong gale



10 Storm



11 Violent storm



12 Hurricane

FIG. 36 Beaufort Scale of Wind

The following table on pages 54 and 55 is only intended as a guide to show roughly what may be expected in the open sea, remote from land.

It should never be used in the reverse way, i.e. for logging or reporting the state of the sea. In enclosed waters, or when near land, with an off-shore wind, wave heights will be smaller and the waves steeper.

Figures in brackets indicate the probable maximum height of waves.

BEAUFORT SCALE OF WIND
(For a standard height of 10 meters above open flat ground)

BEAUFORT NUMBER	DESCRIPTIVE TERM	VELOCITY EQUIVALENT AT A STANDARD HEIGHT OF 10 METERS ABOVE OPEN FLAT GROUND		
		mean velocity in knots	meters/sec	km/h
0	Calm	< 1	0 - 0.2	< 1
1	Light air	1 - 3	0.3 - 1.5	1 - 5
2	Light breeze	4 - 6	1.6 - 3.3	6 - 11
3	Gentle breeze	7 - 10	3.4 - 5.4	12 - 19
4	Moderate breeze	11 - 16	5.5 - 7.9	20 - 28
5	Fresh breeze	17 - 21	8.0 - 10.7	29 - 38
6	Strong breeze	22 - 27	10.8 - 13.8	39 - 49
7	Near gale	28 - 33	13.9 - 17.1	50 - 61
8	Gale	34 - 40	17.2 - 20.7	62 - 74
9	Strong gale	41 - 47	20.8 - 24.4	75 - 88
10	Storm	48 - 55	24.5 - 28.4	89 - 102
11	Violent storm	56 - 63	28.5 - 32.6	103 - 117
12	Hurricane	64 and over	32.7 and over	118 and over

Sea	Probable wave height in meters	Probable wave height in feet
Sea like a mirror	-	-
Ripples with the appearance of scales are formed, but without foam crests	0.1 (0.1)	1/4 (1/4)
Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break	0.2 (0.3)	1/2 (1)
Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses	0.6 (1)	2 (3)
Small waves, becoming longer; fairly frequent white horses	1 (1.5)	3 1/2(5)
Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray)	2 (2.5)	6(8 1/2)
Large waves begin to form, the white foam crests are more extensive everywhere (probably some spray)	3 (4)	9 1/2(13)
Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind	4 (5.5)	13 1/2(19)
Moderately high waves of greater length; edges of crests begin to break into the spindrift; the foam is blown in well-marked streaks along the direction of the wind	5.5 (7.5)	18 (25)
High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility	7 (10)	23 (32)
Very high waves with long overhanging crests; the resulting foam, in great patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance; the tumbling of the sea becomes heavy and shock-like; visibility affected	9 (12.5)	29 (41)
Exceptionally high waves (small and medium-sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected	11.5 (16)	37 (52)
The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected	14 (-)	45 (-)

Another instrument to measure the wind speed is the hand anemometer. It usually has a set of small rotating cups and a dial from which the wind speed is read. It should be well exposed to the wind, at the windward side of the ship. Because the air currents which flow at low levels over the ship are usually disturbed by the ship itself, hand anemometer reading are not very reliable. Such wind meters may, however, serve as an aid to inexperienced observers on board fishing vessels.

Another type of hand anemometer, which has recently been invented by a Japanese meteorologist, is shown in Figure 37. The meter consists of a quarter-circle arm and a mobile sensor of metal net. The net lists as the wind speed increases. The scale on the arm gives the wind speed in m/s and also the wind force in Beaufort numbers.

When wind speeds are measured with a hand anemometer, the readings should be corrected for the ship's speed and course in order to obtain the true wind.

In order to estimate the wave height the following table may be useful to fishermen. If a wind blows continuously in one direction over the ocean, the wave height is governed by the duration and distance of the wind blowing (known as fetch). Wave height increases with the duration and fetch, as is shonw in the table.

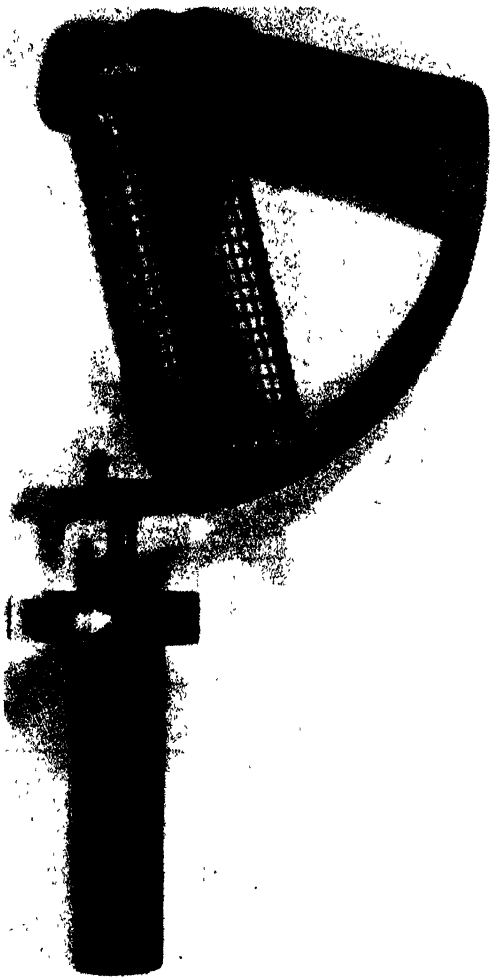


Fig. 37 Hand anemometer

Wave heights, in metres, in relation to speed, duration and fetch of the wind

Wind speed	Duration	Fetch (nautical mile)				
m/s	h	10	20	60	100	200
7	5	0.8	0.9	1.0	1.0	1.0
	10	0.8	0.9	1.1	1.1	1.1
	15	0.8	0.9	1.2	1.3	1.3
10	5	1.2	1.4	1.6	1.6	1.6
	10	1.2	1.4	1.9	2.1	2.1
	15	1.2	1.4	1.9	2.3	2.4
13	5	1.5	1.8	2.2	2.2	2.2
	10	1.5	1.8	3.0	3.3	3.3
	15	1.5	1.8	3.0	3.4	3.7
17	5	1.8	2.6	3.6	3.6	3.6
	10	1.8	2.6	4.2	5.2	5.3
	15	1.8	2.6	4.2	5.2	6.2

This shows that if a wind of velocity 10 m/s blows over 100 nautical miles, the waves become 1.6 m after 5 hours, and 2.3m, after 15 hours, and so on. But if the fetch is as little as 20 miles, the wave height remains unchanged according to the duration of wind.

5.4 Temperature

When using the ordinary mercury thermometer, special precautions should be taken to prevent direct radiation which would have an effect on the mercury, and for this reason a shelter is used. But on board ship, except for specialized work, a shelter is not recommended. When recording the temperature the observer should take care to avoid direct solar radiation and it is recommended that the air temperature be recorded in the open air on a shady part of the deck by a sling-type thermometer.

The temperature of sea water is also very important for fishing operations. Fishermen should take samples of water in a bucket and measure the temperature with an ordinary thermometer. To avoid the thermal effect of the bucket (too hot or too cold as compared with the water), the bucket should be filled with water twice and the temperature of the second bucket of water should be recorded. Moreover water very close to the ship should be avoided, because of the effect of reflection from the ship's hull caused by direct solar radiation, and of course to avoid taking a water sample which includes water from the ship's condenser or other discharge pumps.

It is not easy, even for professional meteorologists, to make accurate recordings of sea surface temperature on board ship but they should read to within a margin of 0.1°C if possible.

The observation of sea surface temperature is especially important for fishermen, since it is closely related to fishing operations.

Where observation of sea surface temperature is particularly important some ships have an electric recording thermometer fitted to the cooling water intake.

Apart from accurate recording of sea surface temperature, fishermen in some advanced countries have recently begun to record temperature at various depths. In doing so conventional oceanographic instruments are often used, but some fishermen use the remote reading electric thermometer which is lowered to the desired depth and the temperature of the water is then registered on an instrument on board ship. The accuracy of this instrument is quite good, to within 0.1°C, but unless there is also a depth recorder the drift of the vessel can cause serious errors in depth estimation.

Thus similar measurements of sea temperature are also made with the bathythermograph, which shows the sea temperature curve according to the depth. The result sometimes shows a rapid change of temperature with increasing depth and this information can be utilized effectively for some fishing operations, such as tuna long-lining. Such fishermen are highly recommended to measure the temperature at different depths, in addition to the surface temperature, in order to aid fishing operations.

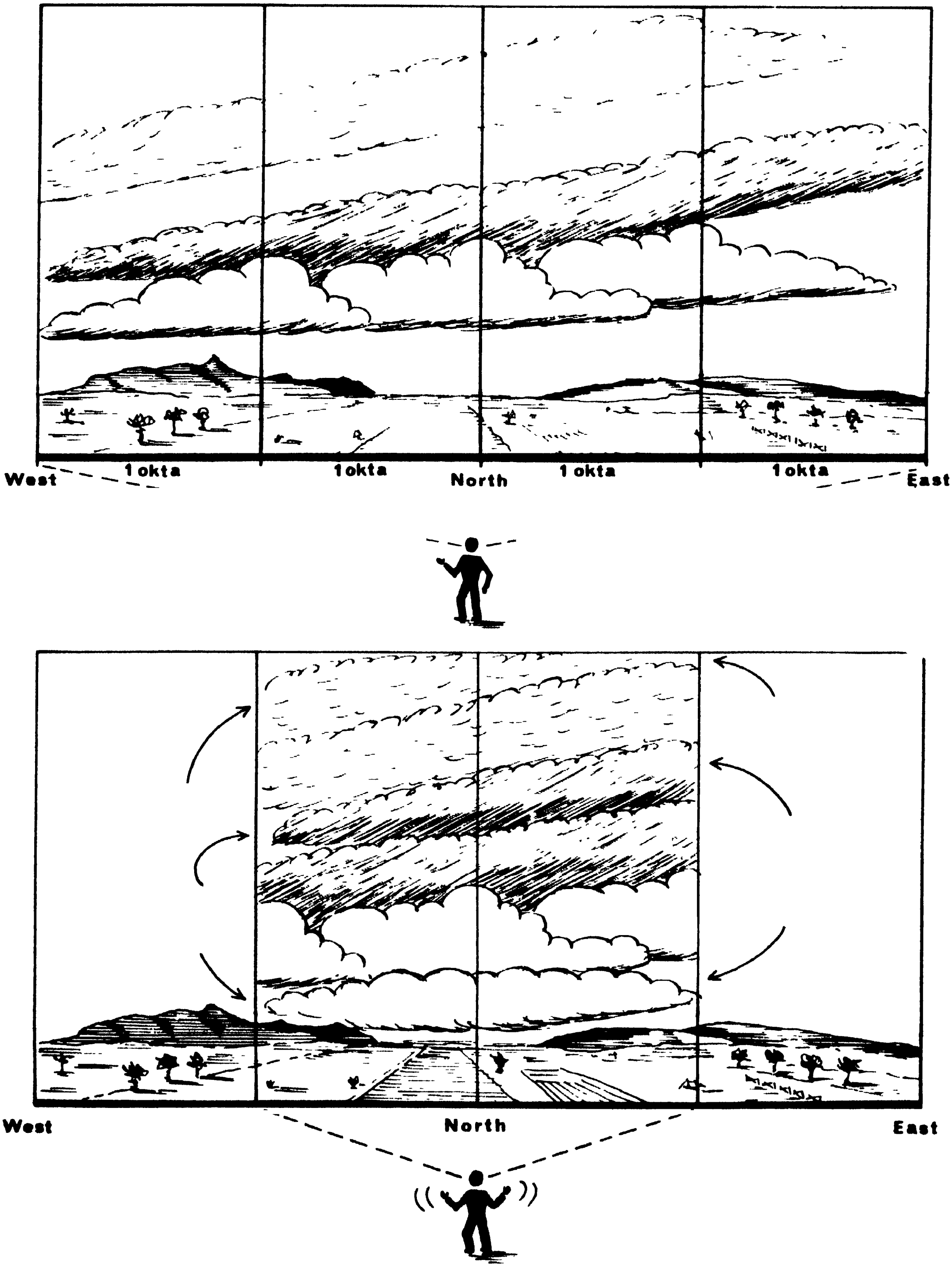


Fig. 38 Visual observation of cloud amount

5.5 Visual observation

There are certain elements of weather which can be recorded by visual observation, such as cloud amount, cloud form, visibility and the state of the sea, etc.

Cloud is a good indication of weather. The meteorologist classifies clouds with great precision and experts produce very complex reports. This information is very helpful in the analysis of weather but it is too troublesome for the amateur. It is therefore better for the beginner to observe cloud amount only.

The cloud amount signifies the amount of sky estimated to be covered by cloud. This is expressed by an okta which is a unit meaning 1/8th. This is a little difficult for beginners to understand, but one may suppose that the celestial dome is divided into 8 parts, as is shown in Fig. 38, and if an observer were able to stand in the center of the dome and visually collect the clouds scattered in the sky to be included in a number of oktas, he would then estimate them as a unit of oktas. Therefore the estimated cloud amount is made to the nearest okta and is reported according to the code form. In this code form there is a corresponding quantity of cloud amount expressed by a fraction of the total sky. For example the total cloud is considered to be included in two oktas. This signifies that 20 - 30% of the total sky is covered by cloud.

We normally use our common sense when describing weather conditions, as for instance "fine weather" when the sun is shining. This is sufficient though in meteorology weather is classified partly according to cloud amount.

Visibility is very important for fishing operations and sailing. It is sometimes impossible to see even several meters ahead in dense fog, and we classify visibility according to the distance we can see. On land it is quite easy to measure distance and meteorologists can make accurate classification. But at sea it is much more difficult and fishermen are encouraged to become acquainted with a simpler method of classification.

6 HOW TO REPORT WEATHER DATA FROM FISHING VESSELS

6.1 Code form

Reported date forms a basic part of weather forecasts for sea areas. A log is kept in all merchant ships and weather data are also recorded there. The ship's officer makes voluntary reports on weather data to coastal stations, which are sent through them, in code form, to the central weather station.

The following simple code[1] is recommended to fishermen; it is composed of five groups each containing five letters, preceded by the letters SHRED (professional meteorologists would use a more complex code system). Information on time of observation, position of ship, amount of clouds, wind direction and speed, visibility, weather pressure and temperature can be transmitted by this code.
The code form is:

SHRED $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $YYGGi_w$ Nddff   VVwwW   PP/TT

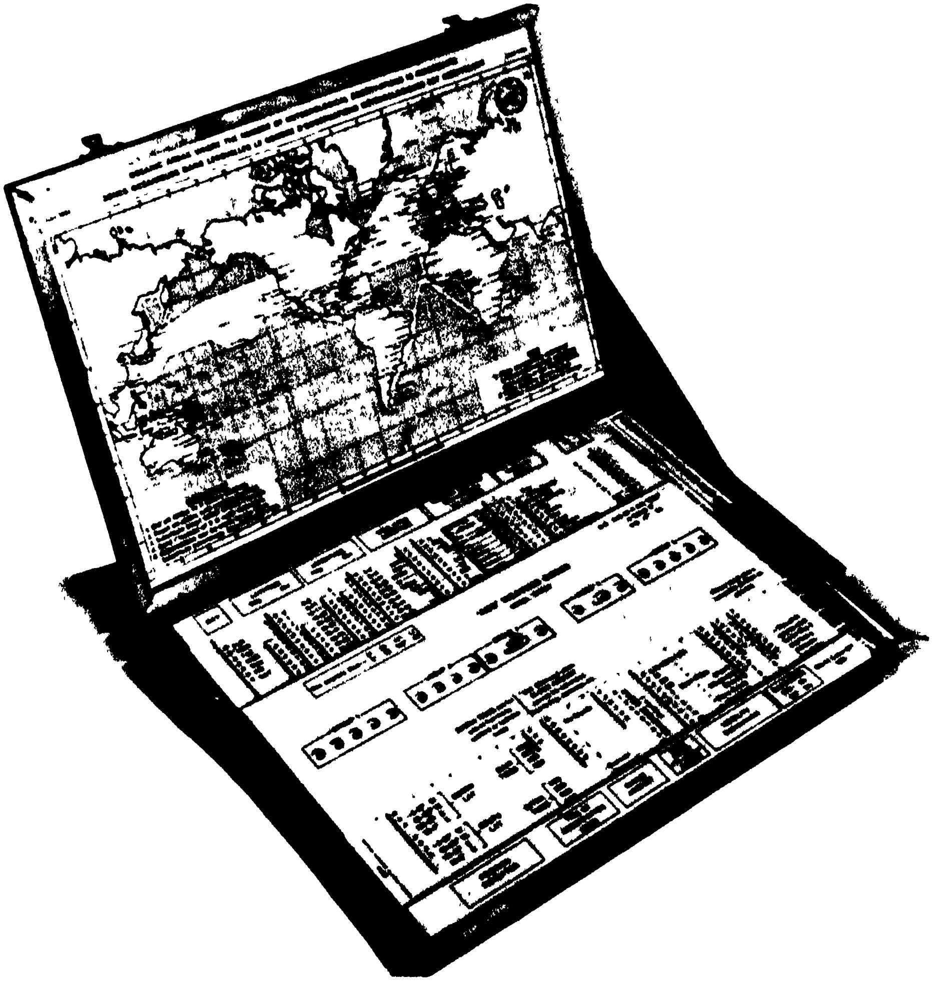


Fig. 39 **ABC weather coder**

---

[1] Readers are advised to apply to the national meteorological office for information on code changes.

The above alphabetical code form can easily be understood from the following table. After using the code several times fishermen will find this system much simpler than it first appears. A handy instrument has recently been invented by Mr. A.B. Crawford, a meteorologist from South Africa, which is a type of slide rule and simplifies the process of translating data into code. This instrument has been manufactured by a company in England as the"ABC" Weather Coder. From the attached photograph it will be seen that it is very simple to handle and would be suitable for fishermen who are busy with operations (Fig. 39)

In the "Weather Reports" (WMO Publication, Volume B Codes) it is stated·

1) The code name SHRED is used as a prefix to the report, indicating that it is a reduced type of ship report (SHips REDuced report). The prefix SHRED should always be included in the messages.

2) This code form is considered suitable for any ship, which is not supplied with tested instruments and may be requested to report in areas where shipping is relatively sparse, or on request and especially when storm conditions threaten or prevail.

   These ships can report in plain language, if the use of code is impracticable. They are encouraged to make their reports at the main standard times of observation, but reports at other hours more convenient to themselves, are acceptable, the actual time of observation being reported in the report to the nearest hour GMT

3) The / in the group PP/TT signifies that the information in tenths of millibars is not available owing to lack of accuracy or closeness of scale of the ship's barometer.

   In the SHRED code there are other additional groups, such as ship's course, ice accretion on ships or ice conditions etc., but on a telegram such descriptions have been omitted.

   We find the words "can report in plain language" which means that if fishing boats are able to observe the sea surface temperature, fishermen can include this point in plain language at the end of the SHRED code. For example, sea temperature 15.

   As the code name SHRED is used as a prefix, and this telegram is sent to the weather bureau of the related country through the allocated coastal station, fishermen are not requested to pay any money for transmission.(See next section).

The following example will show how the code is formed:

A fishing boat is operating in the oceanic area west of India on 7 January 1964. The position is 8° 20'N, 65° 30' E and the recorded time is 16 h LMT (12 h GMT). Cloud is observed over about one-quarter of the sky and the wind is blowing from the North (force 3, Beaufort scale). Visibility is bad and the pressure is found to read 1013 mb and air temperature 23°C. The weather is good, having been rather rainy.

Abbreviated Explanation of the Code form SHRED

SHRED $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $YYGGi_w$ Nddff VVwwW PP/TT

Symbolic Letters	Explanation
Q_c	Quadrant of the Globe
$L_aL_aL_a$	Latitude, in tenths of degrees
$L_oL_oL_oL_o$	Longitude, in tenths of degrees
YY	Day of the month
GG	Actual time of observation, to the nearest whole hour GMT
i_w	Wind indicator
N	Cloud amount, in okta's
dd	True direction from which the wind is blowing, in tens of degrees of arc 360° (cycle starting clockwise from North)
ff	Wind speed, in knots or in metres per second

Code figures

Code figure	Latitude	Longitude
1	North	East
3	South	East
5	South	West
7	North	West

Lat. 8° 20' ---- 083
Long. 65° 30' ---- 0655
Long. 114 18' ---- 1143

01 means 1st day of the month, 02 means 2nd day of the month, etc.

Report by Greenwich Mean Time, for example:

0600 GMT ---- 06, 1200 GMT ---- 12

Wind Indicator	0	Wind speed estimated)	Wind speed in metres per second
	1	Wind speed from anemometer)	
	3	Wind speed estimated)	Wind speed in knots
	4	Wind speed from anemometer)	

The fraction of the celestial dome covered by cloud.

0	**0**	**6**	**6/8**
1	**1/8 or less, but not zero**	**7**	**7/8 or more, but not 8/8**
2	**2/8**	**8**	**8/8**
3	**3/8**	**9**	**sky obscured, or cloud amount cannot be estimated**
4	**4/8**		
5	**5/8**		

Generally the true direction of the wind observed on board fishing vessels cannot be so accurately determined as on the land. So the following allocations are recommended:

00	**Calm,**	**02**	**NNE,**	**05**	**NE,**
07	**ENE,**	**09**	**E,**	**11**	**ESE,**
14	**SE,**	**16**	**SSE,**	**18**	**S,**
20	**SSW,**	**23**	**SW,**	**25**	**WSW,**
27	**W,**	**29**	**WNW,**	**32**	**NW,**
34	**NNW,**	**36**	**N,**	**99**	**Variable or unknown**

When the observation is made by Beaufort scale, the following corresponding mean speed is knots is reported:

Beaufort	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
ff	**00**	**02**	**05**	**08**	**13**	**18**	**24**	**30**	**37**	**44**	**52**	**59**	**67**

Abbreviated Explanation of the Code form SHRED (Continued)

SHRED $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$ $YYGGi_w$ Nddff VVwwW PP/TT

Symbolic Letters	Explanation
VV	Horizontal visibility
ww	Present weather
W	Past weather
PP	Barometric pressure, in millibars (minus 1000 or minus 900)
TT	Air temperature, in degrees Celsius

Code figures

Two figures are allocated in the following way:

Code figure	km	Yard (approx.)	Remarks
90	< 0.05	< 55	
91	0.05	55	
92	0.2	220	
93	0.5	550	
94	1	1100	
95	2		(poor)
96	4		(moderate)
97	10		(good)
98	20		(very good)
99	> 50		(excellent)

For professional meteorologists or trained observers, the full WMO code ww must be used; but for fishermen fhe following abbreviated code is more suitable:

00 or 01	Fine - fair	53	Drizzle
03	Cloudy - overcast	63	Raining
10	Mist	73	Snowing
16	Rain in sight	81	Showers
45	Fog	95	Thunderstorm

Weather since the previous report:

0	Fine	5	Drizzle
1	Partly cloudy	6	Rain
2	Overcast	7	Snow
3	Sandstorm	8	Shower
4	Fog	9	Thunderstorm

Value of atmospheric pressure in mb., omitting the initial digits 10 or 9. For example:

1035 mb ------ 35, 957 mb ----- 57

Whole degrees Celsius
If the temperature is below 0°C, the number 50 is added:

- 3°C ----- 03 + 50 = 53

Fishermen should send out a code report on the above observation. The first two figures 99 are always included. Q_c is 1, so that the first two groups read: 99083 10655. When the wind speed is estimated and reported in knots, i_w is 3 and the third group reads: 07123. On the table N is 2 and wind is indicated by four figures (36 for dd and 08 for ff); the fourth group is 23608; the fifth group is 95006, being 95 for poor visibility, 00 for good weather and 6 for past weather, and the last group is shown by the value of pressure and temperature. We thus have the complete code as follows:

SHRED	9 9 0 8 3	1 0 6 5 5	0 7 1 2 3	2 3 6 0 8	9 5 0 0 6	1 3/2 3
	9 9 $L_aL_aL_a$	$Q_cL_oL_oL_oL_o$	Y Y G G i_w	N d d f f	V V w w W	P P/T T

The code message may be made by using the Crawford coder. The cloud amount is first obtained by looking at the sky, and then the needle of the coder should be placed at the corresponding figure which denotes the cloud amount, and the pen moves vertically to the desired code number. Pressure and temperature readings are obtained with the aid of an instrument and it is not necessary to use the conversion table for coding them.

Fishermen may be reluctant to send in a report if some elements have not been observed or the data are insufficient to put into good code, and in that case the gap in the code may be filled in with the sign "/". If, for example in the sample report we have given, the pressure had not been observed, or was not accurate, the last group of the code message would be ///23.

If there is other information which is difficult to put into code, it may be reported in plain language, as is explained before.

6.2 Where should the code be sent?

Once the fishermen have converted the data into code, as we have shown, the radio operator should contact the nearest coastal station. The method of contact is determined by WMO regulations. If, as in the example, the fishing boat is operating in the western part of the Indian ocean, the countries suitable to receive information are Aden, India, Pakistan, and Ceylon (according to WMO Publication No.9 Vol.D).

The operator is responsible for the selection of the station. For example he might want to contact Bombay and to do this he would call Bombay on frequency 8354-8374 and send the code to OBS WEATHER. The radio station may often be busy and it will be necessary for the operator to wait for some time. In that case he could contact another station, such as Karachi or an auxiliary station if there is one.

It is not necessary to pay any transmission costs. As soon as the message is received it is sent to the central meteorological station of India (in the above case) and this cost is born by the Indian Government.

The data are then used for weather analysis and also re-broadcast through transmission stations. So if the fishermen were to hear the bulletin, they might find that their report had been used as the basic data of the weather forecast.

All fishermen have to do, therefore, is to make observations on the weather and transmit the information in code to the coastal station.

There is sometimes reluctance to report the ship's exact position from the economical aspect of the fishing operation (through publicizing information on good fishing grounds). But this problem may be solved by adopting a system of cipher which would be known to fishing vessels and the relevant meteorological services. This system is now being successfully used by the whaling fleet in the Antarctic.

EXPLANATION OF THE COLUMNAR ARRANGEMENT OF THE INFORMATION ON COASTAL RADIO STATIONS ACCEPTING SHIPS' WEATHER REPORTS

Column 1: Name of the Station (Date)

This column shows the name of the coastal radio station and is followed by the date on which the information was supplied.

The names of HF Coastal radio stations designated for the reception of ships' weather reports from high seas shipping are underlined.

Column 2: Country

This column shows the country in which the coastal radio station is located. For ocean weather stations, the column indicates the operating country.

Column 3: Type of station

In this column coastal radio stations are classified into three types as follows:

a - Stations keeping a continuous 24-hour watch.

b - Stations keeping a watch for at least 30 minutes, beginning at 0000, 0600, 1200 and 1800 GMT daily. At type b station it is understood that at these periods and other hours the order of priority will be maintained, which, according to Article 37 of the Radio Regulations, is to be given to the Transmission of Ships' weather reports in the mobile service and that watch will also be kept for a similar minimum time at the beginning of the nearest "single operator period" following those standard synoptic hours.

c - Stations keeping watch for shorter periods (stations with limited hours of operation) than type b stations. Stations of type c should be included in Volume D only when they are considered of particular value because they are located in an area where coastal radio stations are sparse, and with the agreement of the President of the Commission for Maritime Meteorology.

Column 4: Location

This column shows the geographical co-ordinates of the transmitting antenna.

Column 5: Call-sign

This column indicates the call-sign of the coastal radio station for each frequency or frequency series used.

Column 6: Class of emission

This column specifies the class of emission of the frequencies indicated under columns 7, 8, 9 and 10.

The following symbols are used:

A - Amplitude modulation:

A1 - Telegraphy without the use of a modulating audio frequency (by on-off keying)

A2 - Telegraphy by the on-off keying of an amplitude-modulating audio frequency or audio frequencies, or by the on-off keying of the modulated emission (special case: an unkeyed emission amplitude modulated)

A3 - Telephony, double sideband

A3J - Telephony, single sideband, suppressed carrier

F - Frequency (or phase modulation);

F3 - Telephony

Column 7: Receiving frequencies/watch
This column gives the frequencies or the bands of frequencies on which the radio coastal station keeps watch.

Column 8: Receiving frequencies/working
This column indicates the frequencies on which the coastal radio station receives the traffic.

Column 9: Transmitting frequency/call
This column indicates the frequencies used by the coastal radio station for calling and for preparatory signals.

Column 10: Transmitting frequencies/working
This column indicates the frequencies on which the coastal radio station transmit the traffic.

Column 11: Hours of operation
This column shows (in GMT) the hours of operation for the frequencies indicated in columns 7, 8, 9 and 10.

Column 12: Radio address of Meteorological Center
This column indicates the address with which ships' weather reports should be headed when transmitted to the coastal radio station. In accordance with the recommended procedure the five-letter abbreviation "METEO" should be used as the first word in the address of ships' weather reports.

Column 13: Remarks
This column provides information supplementing that given in columns 1 to 12.

COASTAL RADIO STATIONS (EXAMPLE) ACCEPTING SHIPS' WEATHER REPORTS

1	2	3	4	5	6	7
Chittagong	Pakistan	a	22°21'N 91°50'E	ASC	A2	500
(1.VIII.1965)					A1	12531-12561
					A1	8354-8374
					A1	16708-16748
					A1	6265.5-6280.5
Karachi	Pakistan	a	24°51'N 67°03'E	ASK	A2	500
(1.VIII.1965)					A1	8354-8374
					A1	12531-12561
					A1	4177-4187
Aden	Aden	a	12°49'N 44°54'E	ZNR	A1 A2*	500
(17.VIII.1965)					A1	8354-8374
					A1	12531-12561
					A1	16708-16748
Colombo Radio	Ceylon	a	06°55'N 79°53'E	4 PB	A2	500
(25.X.1965)					A1	8354-8374
					A1	12531-12561
Bombay	India	a	18°56'N 72°50'E	VTF 4	A1 A2	500
(24.XII.1965)				VTF 4	A1	8354-8374
				VTF 5	A1	12531-12561
				VTF 6	A1	16708-16748
			19°05'N 72°50'E	VWB	A1 A2*	500
					A1	8354-8374
					A1	12531-12561

8	9	10	11	12	13
466	500	466	0000-2400	Weather	
12 Mc/s band	13056	13056	0000-0600		
8 Mc/s band	8694	8694	1200-2200		
16 Mc/s band	17050	17050	0600-1200		
6 Mc/s band	6414	6414	2200-2400		
484	500	484	0000-2400	Weather	
8 Mc/s band	8694	8694	0000-0400 1700-2100		
12 Mc/s band	13024	13024	0400-1700		
4 Mc/s band	4250	4250	2100-2400		
1)	500	476	0000-2400	MET Aden	*A2 on 500 kc/s 1) According to frequency used by ship
8 Mc/s band	8710	8710	0500-0700 1100-1200 1630-1800 1830-1930 2130-2200		
12 Mc/s band	13060.5	13060.5	0900-1100 1300-1500		
16 Mc/s band	17175.2	17175.2	0700-0800		
	500	482	)	WEATHER Colombo	Power 2.5 kW
			) 0000-2400		
8 Mc/s band	8742	8742	)		
12 Mc/s band	12925.5	12925.5	)		
	500		)	METEO Weather	
			)		
8 Mc/s band	8566		) 0000-2400		
12 Mc/s band	12849		)		
16 Mc/s band	17132		)		
415-490	500	476	)		*A2 on 500 kc/s
			) 0000-2400		
8 Mc/s band	8514	8514	)		
12 Mc/s band	12966	12966	)		

7 CONCLUSION

Fishing operations are closely connected with the economic life of the individual fishermen and the fishing companies. Operations are made both in the coastal areas and at a great distance out to sea, when fishermen are obliged to stay on board for many days and months. During that time they may encounter various weather conditions and will have the experience of avoiding storms and going through fog; but in general fishermen have no experience in contacting the weather stations and do not know how the weather services function. They merely take the weather and weather forecast for granted. This is because they do not know enough about the organizations of the weather service, which was promoted internationally for the benefit of mankind.

The service is controlled by Government agencies in order to provide information for the public. Fishermen may also utilize this information service although it is not specialized, being intended for the general public. Special weather services for shipping have been authorized nationally and internationally, but they are broadcast by very few countries.

As may be seen from the examples given, co-operation is beneficial to both fishing operations and meteorological analysis. This booklet has therefore given a simple introductory explanation on weather, how to make contact with the meteorological stations and how weather reports are made on the fishing grounds.

Fishermen will find that the observation and reporting of weather are not really complicated, and their collective efforts will be rewarded by better results in their fishing activities.

****

FAO hopes that each member country will publish more comprehensive manuals for the use of their own fishermen, in consultation with the respective meteorological office, and is happy to think that this small booklet may serve as a guide.

APPENDIX I

Some technical words used in weather bulletins

ENGLISH	FRENCH	SPANISH
Air mass	Masse d'air	Masa de aire
Warm (cold) air mass	Masse d'air chaud (froid)	Masa de aire caliente(fri
Anemometer	Anémomètre	Anemómetro
Aneroid	Anéroide	Aneroide
Anticyclone	Anticyclone	Anticiclón
Barograph	Baromètre enregistreur, barographe	Barógrafo
Barometer	Baromètre	Barómetro
Mercury barometer	Baromètre à mercure	Barómetro de mercurio
Self recording barometer	Baromètre enregistreur	Barómetro registrador
Barometric tendency	Tendence barométrique	Tendencia barométrica
Beaufort scale	Echelle de Beaufort	Escala de Beaufort
Broadcast	Emission	Radiodifusión
Continental broadcast	Emission continentale	Radiodifusión continenta
Regional broadcast	Emission régionale	Radiodifusión regional
Cloud (a)	Nuage (a)	Nube (s)
Cloud amount	Nébulosité (quantité de nuages)	Cantidad de nubes
High cloud	Nuage supérieur	Nube superior
Low cloud	Nuage inférieur, bas	Nube baja
Thunder cloud	Nuage d'orage	Nube tormentosa,nubarrón
Cloudiness	Nébulosité	Nebulosidad
Code	Code	Clave
Cyclone	Cyclone	Ciclón
Deepening (of a depression)	Creusement (d'une dépression)	Intensificación de una depresión
Depression, low	Dépression, perturbation	Depresión baja presión
Development	Evolution	Evolución
Discontinuity	Discontinuité	Discontinuidad
Doldrums	Zone de calmes équatoriaux	Zona de calmas ecuatoriales

APPENDIX I (Continued

ENGLISH	FRENCH	SP SH
Eye of storm	Oeil de la tempête	Ojo de empestad
Fog	Brouillard	Niebla
Advection fog	Brouillard d'advection	Niebla de advección
Sea fog	Brouillard de mer	Niebla maritima
Radiation fog	Brouillard de rayonnement	Niebla de radiación
Forecaster	Prévisionniste	Pronosticador
Front	Front	Frente
Warm front	Front chaud	Frente caliente
Cold front	Front froid	Frente frior
Polar front	Front polaire	Frente polar
Gale	Coup de vent	Temporal
Glazed frost (U.S. glaze, clear ice	Verglas	Helada cristalina
Gradient	Gradient (Horizontal)	Gradiente
Pressure gradient	Gradient (Horizontal) de pression	Gradiente de presión
Gust	Rafale	Ráfaga
High (anticyclone	Zone de haute pression, anti-cyclone	Alta presión, anticielón
Hour	Heure	Hora
Humidity	Humidité	Humedad
Hurricane	Ouragan	Huracán
Hygrometer	Hygromètre	Higrómetro
Hairhygrometer	Hygromètre à cheveu(x)	Higrómetro de cabelle
Ice accretion	Accumulation de glace	Accumulación de hielo
Ice formation	Formation de glace	Formación de hielo
Icing conditions	Conditions de formation de glace	Condiciones de formación de hie
Information	Renseignement	Información

APPENDIX I (Continued)

ENGLISH	FRENCH	SPANISH
Isobar	Isobare	Isóbara
Isotherm	Isotherme	Isoterma
Lapse rate	Gradient vertical	Gradiente vertical
Latitude	Latitude	Latitud
Lightning	Eclair	Relámpago
Log	Livret	Libro
Meteorological log	Livret meteorologique	Cuaderno meteorológico
Longitude	Longitude	Longitud
Monsoon	Mousson	Monzon
Movement(of a front, etc.)	Deplacement (d'un front, ecc)	Desplazamiento (de un frente, etc
Observation	Observation	Observación
Observer	Observateur	Observador
Polar air	Air polaire	Aire polar
Pressure	Pression	Presión
Prevailing	Dominant	Dominante
Prognostic analysis	Analyse prevue	Analisis del prognosis
Prognostic chart	Carte prevue	Carta de prógnosis
Radiation	Rayonnement	Radiación
Rain	Pluie	Lluvia
Report	Message, message d'observation, observation	Informe
Sea	Mer	Mar
Rippled	Ridée	Rizeda
Rough	Houleuse	Brava
Glass	Mer d'huile	Mar espejo
High	Grosse	Gruesa

APPENDIX I (Continued)

ENGLISH	FRENCH	SP SH
Moderate	Agitée	Agitado
Phenomenal	Enorme	Tempestuosa
Smooth	Belle	En bonanza
Scale of wind forces	Echelle anémométrique	Escala de fuerzas del viento
Seasons	Saisons	Estaciones del año
Self recording instrument	Instrument enregistreur	Instrumento registrador
Shower	Averse	Chubasco, aguacero
Sky	Ciel	Cielo
Snow	Neige	Nieve
Snow cover	Couche de neige	Capa de nieve
Melted snow	Neige fondue	Nieve fundida
Squall	Grain	Turbonada
State of swell in open seas	Etat de la houle au large	Estado del oleaje en alta mar
Station	Station	Estación
Automatic weather station	Station d'observation automatique	Estación meteorológica automáti
Ocean weather station	Station météorologique océanique	Estación meteorológica oceánica
Synoptic chart	Carte synoptique	Carta sinóptica
Storm	Tempête	Tormenta
Tropical storm	Tempête tropicale	Tormenta tropical
Thermometer	Thermomètre	Termómetro
Dry bulb thermometer	Thermomètre sec	Termómetro seco
Wet bulb thermometer	Thermomètre mouillé	Termómetro humedo
Sling thermometer	Thermomètre a fronde	Termómetro honda
Self recording thermometer	Thermomètre enregistreur	Termómetro registrador
Thermograph	Thermographe, thermomètre enregistreur	Termógrafo
Thunder	Tonnerre	Trueno
Thunderbolt	Foudre	Rayo
Thunderstorm	Orage	Tormenta

APPENDIX I (Continued)

ENGLISH	FRENCH	SPANISH
Time	Temps, heure	Hora
Local time	Heure locale	Hora local
Greenwich mean time (GMT)	Temps moyen de Greenwich (TMG)	Hora media de Greenwich
Local mean time (standard time)	Temps moyen local	Hora civil
Tide	Marée	Marea
Trade winds	Alizés	Vientos alisios
Tropical disturbance	Perturbation tropicale	Perturbación tropical
Tropical air	Air tropicale	Aire tropical
Trough	Thalweg, creux (système barique)	Vaguada
Turbulence	Turbulence	Turbulencia
Typhoon	Typhon	Tifón
Units	Unités	Unidades
Warning	Avertissement	Advertencia
Gale warning	Avertissement de coup de vent	Advertencia de temporal
Storm warning	Avertissement de tempête	Advertencia de tormenta
Hurricane warning	Avertissement de ouragan	Advertencia de huracan
Water content	Etat hygrométrique	Contenido de agua
Water vapour	Vapeur d'eau	Vapor acuoso
Wave	Vague	Ola, onda
Weather chart	Carte météorologique du temps	Carta meteorológica del tiempo
Wind direction	Direction du vent	Dirección del viento
Wind force	Force du vent	Fuerza del viento
Wind speed	Vitesse du vent	Velocitad del viento
Squall wind	Grain	Turbonada
Prevailing wind	Vent dominant	Viento dominante

The above has been extracted from the following Italian publication: Bellisario, Amerigo (1951) Terminologia meteorologica in italiano, inglese, francese e spagnolo. Roma, Aeronautica, 17 p.

APPENDIX II

The following is an annex to a letter sent to the Food and Agriculture Organization dated 12 November, 1965 from Mr. D.A. Davies, Secretary-General of the World Meteorological Organization. In this letter Mr. Davies invited the attention of member countries and related organizations to the reporting of weather data, especially from the "sparse" areas. The World Meteorological Organization has prepared many copies of the attached map, which can be obtained there on request.

WEATHER REPORTS FROM SHIPS IN "SPARSE" AREAS (Fig.40)

1. Due to the shortage of weather observations from the "sparse" oceanic areas, ships which are not already transmitting radio weather messages are invited to assist meteorologists throughout the world by voluntarily undertaking to transmit short radio weather messages to the appropriate Meteorological Service WHEN CROSSING THESE "SPARSE" AREAS (SEE MAP). The transmission of these messages to the designated coastal radio stations will be free of cost to the ship. These coastal radio stations are listed in Part B of Volume D of WMO Publication No.9. TP.4.

2. By co-operating in this scheme, you will:

   (a) Improve weather forecasts for shipping and aviation;

   (b) Improve storm warning services;

   (c) Assist in the locating of cyclones, hurricanes and typhoons;

   (d) Contribute to the safety of life at sea and protection of cargo;

   (e) Aid fishing operations in many areas;

   (f) Assist in air-sea rescue operations;

   (g) Help climatological research;

   (h) Aid the weather satellite project.

3. Weather observations sent by radio from ships in "sparse" areas are of EXTREMELY GREAT VALUE throughout the world. A simple code which corresponds to the normal weather observations made by every officer in the ship's deck logbook enables ships to report this information. Details of this code will readily be provided by any port meteorological officer and are also given in such publications as the Admiralty List of Radio Signals, Vol. III.

4. You are therefore cordially invited to co-operate and thereby become an auxiliary reporting ship, so that your weather reports can contribute directly to the benefits mentioned.

APPENDIX III

References

Though there are many books on elementary meteorology, very few deal particularly with meteorology as it affects fishermen and fishing. Even those which do generally give only the rudiments of the subject. Frequently they fail to provide enough details to enable the reader to analyse a weather map. The functions of the World Meteorological Organization are also not described in many books.

A number of publications closely related to this book are listed below.

Brock, V.E., 1964 Report of the working group on rapid utilization of synoptic data and fixed oceanographic stations. Rome. FAO, ACMRR/2/WP.6 (Rev.1)

Hela, I. and T. Laevastu, 1961 Fisheries hydrography; how oceanography and meteorology can and do serve fisheries. London, Fishing News (Books) Ltd., 137 p

Lumb, F.E., 1965 Meteorology of the North Sea; Folio 9, Serial Atlas of the Marine Environment. American Geographical Society.

Petterssen, S., 1958 Introduction to meteorology. Second edition. London, McGraw-Hill Book Co., Inc., 327 p

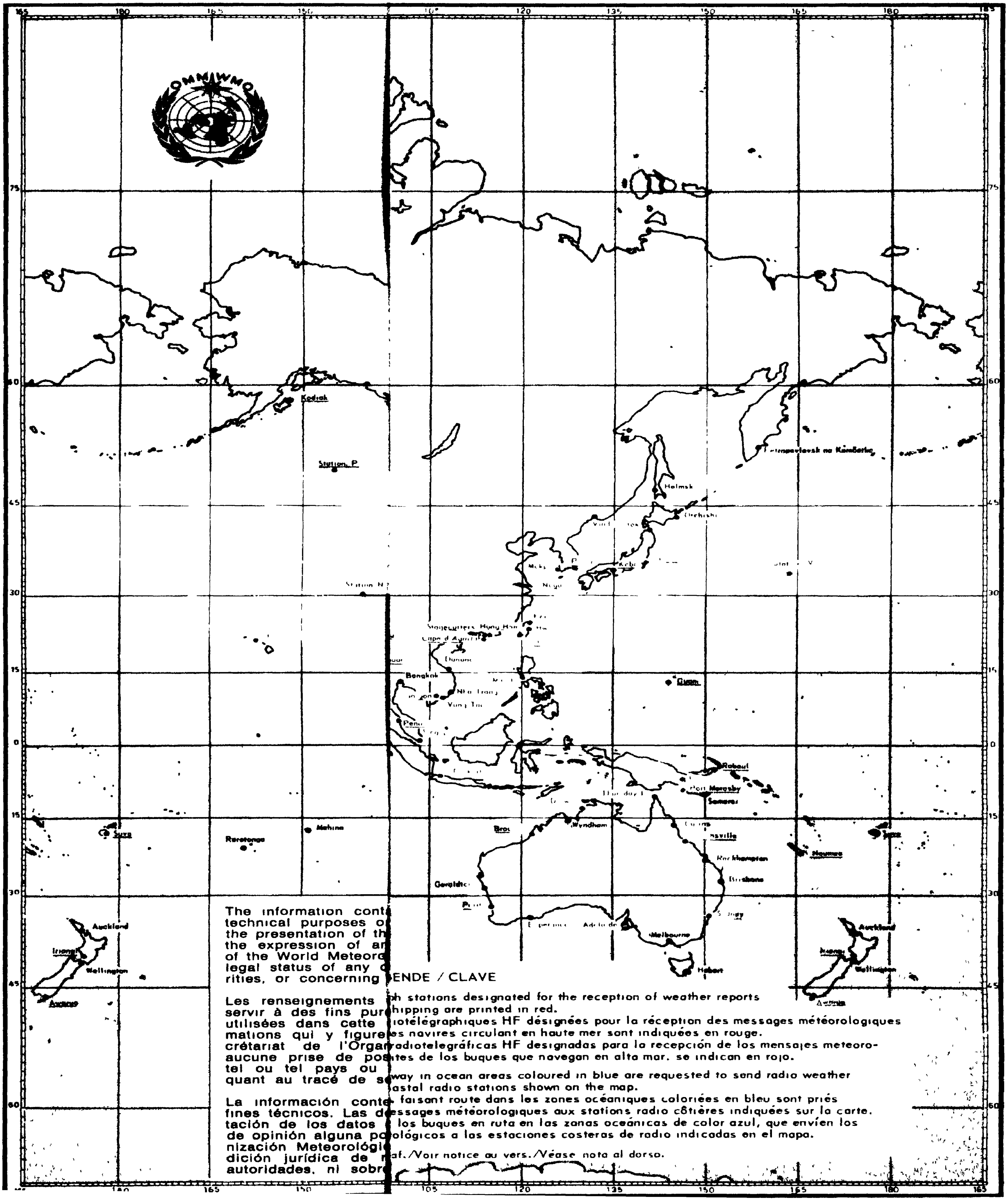
WMO (Geneva) Weather Reporting: Stations, Codes and Transmissions. (publication No. 9.TP.4)
The basic reference publication for operational activities of Meteorological Services.

- Volume A: Observing Stations
- Volume B: Codes
- Volume C: Transmissions
- Volume D: Information for Shipping
    - Part A: International regulations for weather reporting by ships and the provision of meteorological information to shipping
    - Part B: Coastal radio stations accepting ships' weather reports
    - Part C: Port meteoroloigcal officers
    - Part D: Visual storm warning signals
    - Part E: Miscellaneous information
    - Part F: Meteorological broadcast schedules for shipping.

WMO 1966 "The preparation and use of weather maps by mariners" WMO Publication No. 179.TP.89, Technical Note No. 72.

ZONES OCEANIQUERVACIONES METEOROLOGICAS ES INSUFICIENTE

Tous les navires faisant route dans les zones ocs mensajes meteorológicos a las estaciones costeras de radio indicadas en el mapa.



The information conte
technical purposes o
the presentation of th
the expression of an
of the World Meteoro
legal status of any c
rities, or concerning

Les renseignements
servir à des fins pur
utilisées dans cette
mations qui y figure
crétariat de l'Orga
aucune prise de pos
tel ou tel pays ou
quant au tracé de s

La información conte
fines técnicos. Las d
tación de los datos
de opinión alguna po
nización Meteorológi
dición jurídica de
autoridades, ni sobr

ENDE / CLAVE

ph stations designated for the reception of weather reports
hipping are printed in red.
iotélégraphiques HF désignées pour la réception des messages météorologiques
es navires circulant en haute mer sont indiquées en rouge.
radiotelegráficas HF designadas para la recepción de los mensajes meteoro-
ntes de los buques que navegan en alta mar. se indican en rojo.

way in ocean areas coloured in blue are requested to send radio weather
astal radio stations shown on the map.
faisant route dans les zones océaniques coloriées en bleu sont priés
essages météorologiques aux stations radio côtières indiquées sur la carte.
los buques en ruta en las zonas oceánicas de color azul, que envíen los
ológicos a las estaciones costeras de radio indicadas en el mapa.

af./Voir notice au vers./Véase nota al dorso.

e) vous faciliterez les opérations de pêche dans de nombreuses zones;

f) vous faciliterez les opérations de sauvetage aéro-maritimes;

g) vous contribuerez aux recherches climatologiques;

h) vous faciliterez l'exécution du programme de satellites météorologiques.

3. Les observations météorologiques que les navires, circulant dans les zones où les données sont rares, envoient par radio, SONT D'UNE EXTREME UTILITE dans le monde entier. Un code simple qui correspond aux observations météorologiques normales inscrites par chaque officier dans le journal de bord du navire permet la transmission de ces renseignements. Des précisions sur ce code seront très volontiers fournies par tout agent de liaison météorologique dans les ports; on en trouvera également dans certaines publications qui sont normalement disponibles à bord des navires.

4. Vous êtes donc cordialement invité à coopérer à ce projet et à faire ainsi de votre navire un navire d'observation auxilaire dont les messages météorologiques peuvent contribuer directement aux avantages énumérés ci-dessus.

MENSAJES METEOROLOGICOS PROCEDENTES DE LOS BUQUES QUE NAVEGAN EN LAS ZONAS DONDE LOS DATOS SON ESCASOS

1. Debido a la escasez de observaciones meteorológicas que existe en ciertas zonas oceánicas, se invita a los buques que no transmiten aún mensajes meteorológicos a ayudar a los meteorólogos de todo el mundo transmitiendo voluntariamente por radio, al correspondiente Servicio Meteorológico, cortos mensajes meteorológicos CUANDO ATRAVIESEN LAS ZONAS DONDE LOS DATOS SON ESCASOS (véase el mapa del anverso). La transmisión de estos mensajes a las estaciones costeras de radio designadas no ocasionará gasto alguno para los buques. En la Publicación N° 9.TP.4 de la OMM, Volumen D, Parte B, se incluye información completa con respecto a estas estaciones.

2. Cooperando en estas actividades, conseguirá usted:

a) mejorar las predicciones meteorológicas para la navegación marítima y la aviación;

b) mejorar los servicios de aviso de temporal;

c) ayudar a la localización de ciclones, huracanes y tifones;

d) contribuir a la seguridad de la vida humana en el mar y a la protección de las mercancías;

e) facilitar las actividades pesqueras en muchas zonas;

f) facilitar las operaciones de salvamento aero-marítimo;

g) contribuir a las investigaciones climatológicas;

h) contribuir a la realización de los programas de satélites meteorológicos.

3. Las observaciones meteorológicas enviadas por radio por los buques que navegan en las zonas donde los datos son escasos SON DE GRAN UTILIDAD en todo el mundo. Una simple clave que corresponde a las observaciones meteorológicas normales inscritas por cada oficial en el diario de navegación, permite la transmisión de esta información. Los detalles de esta clave pueden ser facilitados por cualquier agente de enlace meteorológico en los puertos y figuran también en ciertas publicaciones disponibles normalmente a bordo de los buques.

4. En consecuencia, se le invita cordialmente a cooperar en este proyecto y a hacer que su navío se convierta en un buque de observación auxiliar cuyos mensajes meteorológicos pueden contribuir directamente a obtener los beneficios enumerados.

FAO FISHERIES TECHNICAL PAPER

This is one of a series of Technical Papers (see inside front cover) dealing with aspects of the work of FAO Fishery Resources and Exploitation Division, including the review of pertinent information on particular topics, to meet requests for assistance, for presentation to technical and scientific meetings, etc. Extra copies can be obtained by application to:

Biological Data Section
Fishery Resources and Exploitation Division
FAO, Rome, Italy

7-1-4-13
9

(Papers issued since January 1966)

FI/T41	Manual of methods for fish stock assessment - Part III. Selectivity of fishing gear	January 1966
FRm/T60	Establishment, structure, functions and activities of international fisheries bodies - III - Regional Fisheries Advisory Commission for the South West Atlantic (CARPAS)	February 1966
FRm/T62	Observations from international oceanographic expeditions relevant to una ecology	April 1966
FRi/T15 Rev. 1 Ad. 1	A list of inland fishery workers in Europe Liste des spécialistes des questions de pêches dans le eaux intérieures en Europe	April 1966
FIb/T51 Suppl. 1	Manual of methods for fish stock assessment - Part IV - Marking Manuel sur les méthodes d'évaluation des stocks ichtyologiques - IV° partie - Le marquage Manual de métodos para la evaluación de los stocks de peces - Parte IV - Marcado	April 1966
FRs/T63	Report on the effects on whale stocks of pelagic operations in the Antarctic during the 1965/66 season and on the present status of those stocks	June 1966
FI/T64	International fishery bodies - Paper presented at the First Session of the Committee on Fisheries - Rome, 13-18 June 1966 Organismes internationaux des pêches - Documents soumis à la première session du Comité des pêches - Rome, 13-18 juin 1966 Organismos pesqueros internacionales - Documentos presentados al primer período de sesiones del Comité de Pesca - Roma, 13-18 junio 1966	August 1966
FRs/T38 Rev. 1	Manual of methods for fish stock assessment - Part II - Tables of yeld functions Manuel sur les méthodes d'évaluation des stocks ichtyologiques - II° partie - Tables des fonctions de rendement Manual de métodos para la evaluación de los stocks de peces - Parte II - Tablas de funciones de rendimiento	September 1966
FRs/T19.1 Suppl. 3	World List of periodicals for aquatic sciences and fisheries Répertoire mondial de périodiques concernant les sciences aquatiques et la pêche Lista mundial de publicaciones periódicas referentes a las ciencias acuáticas y a la pesca	November 1966
FRs/T66	The echo sounder and its use for fishermen	April 1967
FRm/T71	Fishermen and the Weather	February 1968